Biodiversity Assessment and Biodiversity Management Plan of Nanmangalam Reserve Forest, Chennai

Report Submitted to

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1.0 Assessment of Biodiversity

The biological diversity in an area, which is determined by the variety and variability of multiple organisms occupying that area, is an important measure of the health and functionality of the ecosystem. The environmental conditions prevail in the tropical and sub-tropical regions of the world is proven to provide optimum condition for the evolution and co-existence of multiple species in a habitat. This high species diversity and complexity in the functionality provides the tropical systems an inherent resilience to disturbances exerted by different sources, such as, anthropogenic, and natural. In other words, higher the species diversity is, higher the resilience of an ecosystem to disturbance.

India is one of the mega-diversity countries. A nation is designated as a mega-diversity country when a major share of the earth's biodiversity is held within its geo-political limits. Unfortunately, the large human (and livestock) population and the intensive use of land (for agriculture, industries, and urban development) in India have together decimated habitats, weakened ecosystems and exterminated species extensively.

2.0 Ecosystem stability and Species diversity

Ecosystem stability is the ability of an ecosystem to maintain a steady state, even after a stress or disturbance has occurred. In order for an ecosystem to be considered stable, it needs to have mechanisms in place that help it return to its original state after a disturbance occurs. It has been shown that biodiversity of an area has a large impact on the ecosystem stability of that area. Areas with high levels of species and genetic diversity are likely to have a more complex ecosystem, with a variety of food webs and biotic interactions. This increase in complexity makes it more likely that the ecosystem will return to a stable state after a disturbance, because the ecosystem has more ways to respond to a disturbance and fix problems.

2.1 Ecological Indicators

Species diversity in an area is a great indicator of change influenced by any change in the environment over space and time. Ecological indicators are scientific constructs that use quantitative data to measure aspects of biodiversity, ecosystem condition, services, or drivers of change, but no single ecological indicator captures

all the dimensions of biodiversity. Ecological indicators form a critical component of monitoring, assessment, and decision-making and are designed to communicate information quickly and easily to policymakers. Moreover, evaluating the importance of a particular habitat in biodiversity/species conservation point of view is necessary to ascertain or predict the potential causes of any modification to habitat (eg. developmental projects) on its biodiversity in a long run. Accordingly, the present study was carried out in Nanmangalam Reserve Forest (hereafter called NRF) to assess the biodiversity, and threats on biodiversity due to Chennai Metro Rail Phase 2 - Corridor 5.

3.0 Urban Biodiversity

Conservation of biodiversity in urban landscapes is a challenging and daunting task especially where rapid growth in human population and the concurrent infrastructure to sustain a diverse community of people and their livelihoods are evolving at an unprecedented rate. The city of Chennai (erstwhile Madras) is the 34th largest metropolitan city in the world with a current population of about 4.34 million people. It is viewed as one of the most progressive cities of the country, according to ample opportunities for education, employment, and infrastructure (Drescher et al, 2007). Consequently, the boundaries of the city have transformed to include adjacent habitations and villages resulting in the formation of ‘Greater Chennai’. This has resulted in ‘the natural’ being confined to a few habitat islands. The management of these habitat islands though is rather varied. While some are protected and managed by the Tamil Nadu Forest Department, others exist within campuses of educational institutions such as IIT-Madras and Madras Christian College and within campuses maintained by private groups such as the Theosophical Society.

Chennai is amongst the few Indian cities that maintain state-owned nature reserves within and around the metropolitan limits. While the Guindy National Park, Vedanthangal Bird Sanctuary and the Pulicat Lake are amongst the better-protected and publicized nature reserves in and around the City, there are also many others that can be described as ‘little-known’. The Nanmangalam Reserve Forest is one of such nature reserves that has received limited attention, despite being home to a diverse community of plants and animals including several endangered species.

4.0 History of Reserve Forest in Kanchipuram Forest Division

The Kanchipuram (Erstwhile Chengalpattu) forest division was revived on 16th July 1945 largely as a plantation division with headquarters at Kanchipuram. In addition to the planting programme, the division had jurisdiction over 17 panchayat forests and three unreserved lands. It originally consisted of four forest ranges viz. Chengalpattu, Tiruporur, Sriperumpadur and Marakannam. A fifth range viz Tirukoilur was formed during May 1947 and included in Chengalpattu division. Subsequently, Nellore division of Sathiavedu range was also transferred to Chengalpattu division.

During 1954, Chengalpattu division was reconstituted into six ranges viz, Sathiavedu, Tiruvallur, Chingalput, Marakanam, Tirukoilur and Vridachalam. The redistribution of the forest areas in the division became necessary with the implementation of several schemes contemplated under the second five-year plan and consequenty the following three special division were formed in addition to the Chingalpattu territorial division in 1956, namely Cashew division, Adyar Fodder and Pasture division, Chengalpattu, and Rehabilitation division, Cuddalore.

The general reorganization of forest divisions in the state in order to obviate overlapping jurisdictions and to enforce effective divisions lead to the constitution of three independent territorial divisions viz, Saidapet, Chingalpattu and Cuddalore divisions respectively.

With rearrangement of the boundary between Tamilnadu and Andhra Pradesh on the recommendation of the Pataskar Award, a total forest area of 329.06 sq.km of Sathiavedu and a portion of Tiruvallur range was transferred to Andhra Pradesh and Pullur East Block comprising of an area of 7.59 sq.km was taken over from Andhra Pradesh on April 1, 1960. Guindy Reserve Forest of Tambaram range was reconstituted into a separate unit during October 1959 and was transferred to control of the State Wildlife officer during 1960.

Chengalpattu division was primarily a plantation division. The past management of this division was built on the notion of improving the dry and poor forests to meet human demands for livelihood, notably firewood for domestic and cashewnut processing in the adjacent district of South Arcot. . It also had to fulfill the demands imposted by emerging industrial estates, housing colonies, hospitals, agricultural

farms, etc. It is to be highlighted though that as early as 1969, the Conservator of Forests had cautioned about the rapid rate of deforestation. He also remarked that at the prevailing rate, the forests of Chengalpattu would disappear in about 30 to 40 years time unless the demands were discouraged.

Another factor contributing to irretrievable deforestation and permanent damage to the ecology of the division was the large-scale quarrying of granite in the forest near Madras city. For quarrying granite from the reserve forest, fee was collected on the basis of quantity removed; the permit was issued for quarrying and transporting. In 1963, as the system was found defective, the area allotted for quarrying was sold in public auction.

The passing of the Forest Conservation Act in 1982 stopped the quarrying since the Act mandates that prior permission of the Central Government is essential for quarrying in forest areas. As a phase out process, permission was obtained to withdraw the operation over a two-year period. (G.OMs.No.1029/Forest and Fisheries/dt.26.08.1983). There are about 139 quarries in the four forest ranges of Chengalpattu forest division: Tiruvallur Range - 33 quarries, Tambaram Range - 100 quarries, Chingalpattu Range - 1 quarry and Madurandakam Range – 5 quarries. Since 1985, there is a total ban on quarrying in reserve forests.

The Tambaram Forest Range currently consists of 16 reserve forests, namely Mannur RF 223.80 Ha, Pudupair RF145.29Ha, Nallur RF 365.44 Ha, Erumaiyur 68.79Ha, Maganium 368.48Ha, Tambaram 92.52Ha, Pulikaradu 74.92Ha, Nanmangalam 320.92Ha, Vandalur 641.01Ha, Maduraipakkam 182.52Ha, Perumbakkam 85.73Ha, Kumili 487.94Ha, Unamajeri 307.17Ha, Gadalur 718.10Ha, Vadakkupattu 287.34Ha, Vattampakkam 329.43Ha.

5.0 Objectives

The overall objective of the project is to study the impact of metro rail activities affect the biodiversity of Nanmangalam Reserve Forest, and measures to be taken to conserve the biodiversity of Nanmangalam RF.

The specific objectives of the project are as follows:

- To assess the impact of metro rail Phase 2 corridor 5 activities and pressures on the Nanmangalam Reserve Forest and suggest means of

mitigating the detrimental pressures

- To enumerate the flora of Nanmangalam RF and identify flora and their significance in the habitats.
- To enumerate the fauna, their significance, and habitats.

6.0 Methodology

The current study was Carried out in Nanmangalam Reserve Forests of Tambaram Range that were historically leased for quarrying in past. A detailed habitat and biodiversity assessment Nanmangalam RF, the efforts were limited to assessments, primarily due to the limited duration and resources for the study.

In addition to the study of secondary data primarily Working Plans of the TamilNadu Forest Department and literature on flora and fauna, a set of primary methods of data collection were used for the study.

7.0 Description of the study area

The biodiversity study was carried out in the Nanmangalam Reserve Forest (hereafter referred to as NRF) which is located on the eastern side of Tambaram town (about 10km) along the Tambaram and Velachery Road. Spread over an area of 320.92 ha, NRF lies between 12^{o}.91' to 12^{o}.93 N and longitude of 080^{o}.16 'to 080^{o}.18' E. It is administered as part of the Tambaram Forest Range (See Fig1).

The Tamil Nadu Forest Department, in its effort to protect and conserve the Nanmangalam Forest Reserve had initiated a number of plantation programmes, the details of which are provided in the following series of tables. The premise of these efforts was that a) the existing forest was highly degraded b) tree cover needs to be enhanced and c) commercially useful plantations need to be raised for sustainable forestry.

Fig. 1 Map of the Nanmangalam Reserve Forest /Satellite Imagery

NRF is bounded by the erstwhile villages of Sempakkam, Pallikarani, Santhoshapuram and Keezhkatalai. These villages currently constitute the suburban urban habitations of south Chennai.

Results of the ecological demarcation of NRF provide a description of the habitat; as detailed in the following section.

Hillocks

There are about three isolated hillocks ranging from 30m-70m MSL elevation; occupying nearly one half of the habitat in the RF. Hillocks harbour about 90 per cent of dense scrub of NRF. Thorny shrubs and stragglers dominate the vegetation of the hillocks and with sparsely distributed trees. Common plants present in the hillocks are *Lannea coromandelica, Albizia lebbeck*, and shrubs such as *Scutia myrtina, Canthium parviflorum, Tarena asiatica* and *Benkara malabarica*. Ground orchid *Eulophia epidendraea* is also very common in the hillocks.

Plains

Except for the central part of the RF the rest of the area is plains that are covered with plantations, thickets and grasslands. While Eucalyptus plantation occupies most of the plains; there are other plantations as well. The shrub *Carissa spinarum* is common in the plains than the hillocks. The Tamilnadu Afforestation

programme has attempted to improve vegetation cover by planting native tree species in the plains.

Small patches of grasslands dominated by *Aristida setacea* (Broom grass), *Heteropogon contortus* (love grass) and an endemic Lemon grass *Cymbopogon travancorensis* are also found in the plains. These grasslands support a large number of fauna in RF.

Water Bodies

There are five abandoned quarries and three ponds inside the RF. During rainy season, these quarries and ponds are flooded, while continuing to hold water during the drier seasons thereby supporting the resident fauna. *Hydrilla verticillata*, *Ottelia alismoides, Aponogeton natans* and *Nymphaea nouchali* are the common aquatic plants present in the water bodies. Grasses such as *Eragrostis natans, E.unioloides* and *Vetiveria zizanioides* are present along the margins of the water bodies. Birds such as Little Cormorant, White Throated Kingfisher, Common kingfisher, and Pied Kingfisher are commonly seen near quarries. The present study is to assess the biodiversity of Nanmangalam RF for Chennai Metro Rail Phase 2 - Corridor 5.

Flora of the Nanmangalam Reserve Forest

The vegetation of NRF is strictly a scrub with plantations. Eucalyptus plantations (117 ha) dominate the forest. The current study enumerates 449 different species and 4 varieties of flowering plants (angiosperms) belonging to 313 and genera representing 89 different families (Appendix 1). It is the most remarkable species representation anywhere in and around Chennai, including more well known areas such as the Guindy National park and IIT-Madras. This representation is dominated by thorny shrubs such as *Scutia myrtina, Benkara malabarica, Canthium parviflorum* and *Carissa spinarum*, stragglers such as *Mimosa intsia, Pterolobium hexapetalum, Ziziphus oenoplia* and *Acacia caesia* and trees such as *Ziziphus xylopyrus, Z.mauritiana, Acacia leucophloea* and *Eucalyptus tereticornis*. *Leucas diffusa*, *Cymbopogon travancorensis*, *Cynodon barberi*, *Tragus roxburghii, Chrysopogon*

asper, Dimeria acutipes and *Euphorbia corrigioloides* are endemic plants present in Nanmangalam RF. Seasonally flooded areas of NRF provide suitable habitat for the growth of several ephemerals. Insectivorous plants like *Drosera burmannii* and *Drosera indica* and ground orchid's viz., *Eulophia epidendraea* and *Habenaria viridiflora* are common in NRF, where as rare in the other adjoining forests and protected areas in and around Chennai (see Vegetation Map).

The economically important Sandal wood tree is also found in the RF. Single mature individuals of three tree species *Buchanania axillaries, Butea monosperma* and *Lepisanthes tetraphylla* are standing as remnants of past vegetation.

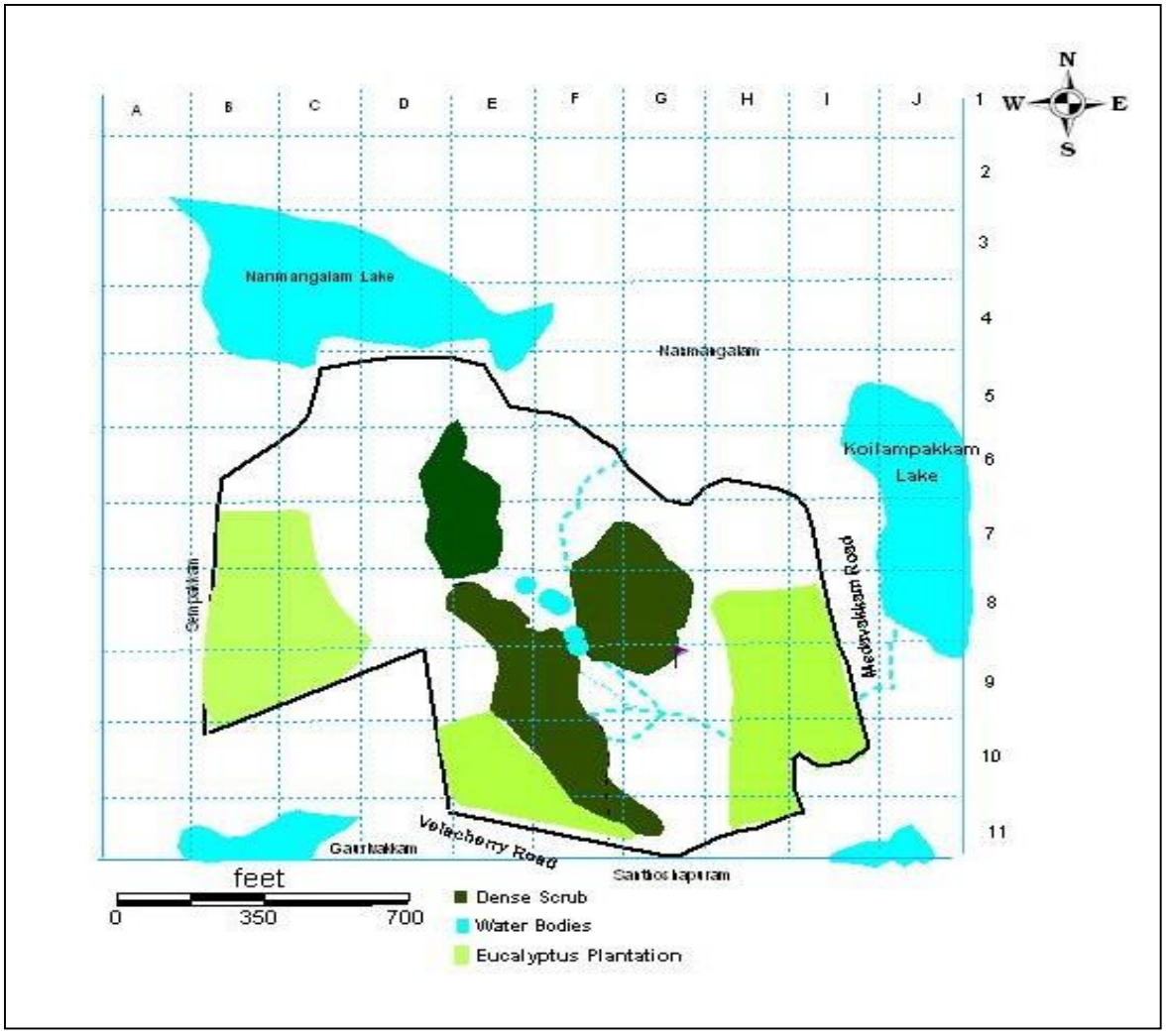

Fig 2. Vegetation Map of Nanmangalam Reserve Forest

8.0 Floral diversity assessment

The diversity of flora was assessed using quadrat method. A total of 10 quadrats of 10 x 10 m were randomly established across the Nanmangalam reserve forest considering the habitat heterogeneity and different vegetation categories. We maintained a minimum of 200 m spatial distance between each plot to cover the heterogeneity in the habitat. All the trees (≥ 20 cm GBH) were enumerated from the quadrats. Shrubs (< 20 cm GBH and >1 cm GBH) were enumerated from nested subplots of 3 x 3 m established at the center of the plot. Similarly, herbs and grasses (< 1.3 m height) were enumerated from the nested subplots of 1 x 1m established at the center of the quadrat. Specimens were collected for species that could not be identified in the field and were identified using regional floras (Gamble & Fischer 1951; Livingstone & Hendry 1994).

Table.1. GPS Location of plot laid in Nanmangalam RF

Plot No.	Latitude	Longitude
1	12.933938	80.167927
2	12.933403	80.171432
3	12.931947	80.165184
4	12.929274	80.16358
5	12.929571	80.17067
6	12.92562	80.164209

7	12.928412	80.175638
8	12.923452	80.172529
9	12.920481	80.172865
10	12.919709	80.176278

8.1 Data analysis

Basic ecological details pertain to the vegetation were calculated using standard protocols (Curtis and Mclntosh 1951). Shannon index (*H'*) was used to calculate the diversity among the vegetation categories (ie. tress, shrubs and herbs) in the quadrats. Importance value index (IVI) for each species was calculated by the following formula for trees. While, for shrubs and herbs the modified IVI was used where only relative density and relative frequency are considered following Rasingam and Parthasarathy (2008). Formula used for calculating the IVI as follows,

$$\text{Relative abundance} = \frac{\text{No. of individuals of a species}}{\text{No. of individuals of all species}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Dominance of a species}}{\text{Dominance of all species}} \times 100$$

IVI = Relative density + Relative frequency + Relative dominance

Data analysis was carried out in Microsoft XL 2016 and R statistical package (ver. 4.0.3).

8.2 Results

We identified a total of 92 plant species from the study plots. The number of species observed for herbs, shrubs and trees were highly varied (Table 1). The ground layer occupied by herbs and grasses showed an exceptionally high species diversity than shrubs and trees. Shannon diversity index and other considered variables (i.e. individuals / plot, species / plot) have also depicted the same pattern. The earlier study found that there about 451 species of flora recorded in Nanmangalam RF (Nehru et al. 2009, Given in Appendix 1 and 2).

Table 2: Ecological values for the vegetation parameters studied.

Variable	Tree	Shrub	Herb
Species encountered	9	17	66
Individuals counted	23	28	255
Species / Plot	1.1±0.74	2.00±1.16	8±2.45
Individuals / Plot	2.5±1.90	2.80±2.25	25.5±13.14
Shannon 'H	0.2±0.33	0.59±0.46	1.78±0.32

Plant species dominance

Eucalyptus tereticornis and *Acacia leucophloea*, both were planted trees, showed the highest IVI values among the trees. Among the native trees *Ziziphus xylopyrus* and *Butea monosperma* showed the highest IVI value (Table 3). Among the shrubs, *Catunaregam spinosa* and *Carmona retusa* were most dominant followed by *Cleistanthus collinus* and *Benkara malabarica* (Table 4). While among the herbs and grasses, *Mitracarpus villosus* and *Plumbago zeylanica* were commonly occurring species followed by *Evolvulus nummularius* and *Eriocaulon quinquangulare* (Table 4). Additionally, many other grass species, namely, *Eragrostiella brachyphylla, Heteropogon contortus,* and *Aristida spp.* are also commonly occurring in the plains.

8.4 Rare species occurrence

In addition to the many species that are commonly found in the tropical dry ever-green forest across the east coast of India, the Nanmangalam reserve forest (NRF) has some species that are very rare. For example, the ground orchids *Habenaria viridiflora* and *Eulophia epidendraea* are found commonly in the marshy areas and hillocks, respectively, inside the NRF. Other such rare species includes, *Utricularia* spp., *Drosera burmanii* (insectivorous plant) and the endemic grass species *Dimeria acutipes* are common in the seasonally flooded eucalyptus plantations in the westward boundary of the NRF. Additionally, there were three endemic species namely *Leucas diffusa, Cymbopogon travancorensis,* and *Chrysopogon asper* are also encountered in our quadrats. The occurrences of the above mentioned rare and endemic plant species highlights the high conservation significance of the Nanmangalam reserve forest.

Table 3 : List of tree species found in the quadrats established at Nanmangalam reserve forest. (R.abu – Relative abundance; R.frq – relative frequency; IVI – Importance value index).

S_No	Species	R_abu	R_frq	R_dom	IVI
1	*Acacia ferruginea* DC.	13.04	9.09	9.51	31.64
2	*Acacia leucophloea* Willd.	8.70	18.18	12.42	39.29
3	*Acacia planifrons* Wight and Arn.	4.35	9.09	2.96	16.40
4	*Albizia lebbeck* (L.) Benth.	4.35	9.09	2.87	16.31
5	*Buchanania axillaris* Ramam.	4.35	9.09	2.59	16.03
6	*Butea monosperma* (Lam.) Taub.	4.35	9.09	6.67	20.11
7	*Eucalyptus tereticornis* Sm.	47.83	18.18	56.18	122.19
8	*Lepisanthes tetraphylla* Radlk.	4.35	9.09	3.46	16.90
9	*Ziziphus xylopyrus* Willd.	8.70	9.09	3.34	21.12
	Grand Total	100	100	100	300

Table 4 : List of shrub species found in the quadrats established at Nanmangalam reserve forest. (R.abu – Relative abundance; R.frq – relative frequency; IVI – Importance value index).

S.No	Species	R_abu	R_Frq	IVI
1	*Atalantia monophylla* DC.	7.14	5.00	12.14
2	*Benkara malabarica* (L.) Tirveng	7.14	10.00	17.14
3	*Breynia vitis-idaea* (Burm.f.) C.E.C. Fisch.	3.57	5.00	8.57
4	*Canthium parviflorum* Lam.	3.57	5.00	8.57
5	*Capparis brevispina* DC.	3.57	5.00	8.57
6	*Carissa spinarum* L	3.57	5.00	8.57
7	*Carmona retusa* (Vahl) Masam.	14.29	5.00	19.29
8	*Catunaregam spinosa* (Thunb.) Tirveng.	14.29	10.00	24.29

9	*Cleistanthus collinus* (Roxb.) Benth. ex Hook. f.	7.14	10.00	17.14
10	*Dodonaea viscosa* (L.) Jacq.	3.57	5.00	8.57
11	*Flacourtia indica* (Burm. f.) Merr.	7.14	5.00	12.14
12	*Lantana camara* L. (weed)	3.57	5.00	8.57
13	*Memecylon edule* Roxb.	3.57	5.00	8.57
14	*Memecylon umbellatum* Burm. f.	3.57	5.00	8.57
15	*Ochna squarrosa* L.	7.14	5.00	12.14
16	*Phyllanthus reticulatus* Poir.	3.57	5.00	8.57
17	*Ziziphus oenopolia* (L.) Mill.	3.57	5.00	8.57
	Grand Total	100	100	200.00

Table 5 : List of herb and grass species found in the quadrats established at Nanmangalam reserve forest.

S_No	species	R_abu	R_Frq	IVI
1	*Acalypha indica* L.	0.78	1.25	2.03
2	*Achyranthes aspera L. var. aspera*	0.39	1.25	1.64
3	*Aerva lanata* (L.) Juss. ex Schul.	2.35	2.5	4.85
4	*Aeschynomene indica* L.	0.39	1.25	1.64
5	*Alysicarpus monilifer* (L.) DC.	1.18	1.25	2.43
6	*Aristida hystrix* L. f. G	3.92	1.25	5.17
7	*Aristida setacea* Retz.	1.57	1.25	2.82
8	*Asystasia gangetica* (L.) T. And.	1.18	1.25	2.43
9	*Basilicum polystachyon* (L.) Moench	1.18	1.25	2.43
10	*Blepharis maderaspatensis* (L.) B. Heyne ex Roth	0.39	1.25	1.64
11	*Bothriochloa pertusa* (L.) A. Camus	0.78	1.25	2.03

12	*Bulbostylis barbata* (Rottb.) C.B. Clarke	1.18	2.5	3.68
13	*Cassia occidentalis* L.	0.39	1.25	1.64
14	*Cassia pumila* Lam	2.75	1.25	4.00
15	*Chrysopogon asper* (B. Heyne) Heyne ex Blatter and McCann	2.35	1.25	3.60
16	*Cleome aspera* Koenig ex. DC.	0.78	1.25	2.03
17	*Cleome viscosa* L.	1.18	1.25	2.43
18	*Corchorus aestuans* L.	0.39	1.25	1.64
19	*Crotalaria prostrata* Rottler ex Willd.	0.39	1.25	1.64
20	*Crotalaria retusa* L.	2.75	2.5	5.25
21	*Cymbopogon travancorensis* Bor	2.75	2.5	5.25
22	*Cynodon dactylon* (L.) Pers.	4.71	1.25	5.96
23	*Cyperus rotundus* L.	1.57	1.25	2.82
24	*Datura metel* L.	0.39	1.25	1.64
25	*Dimeria acutipes* Bor	2.75	1.25	4.00
26	*Drosera burmannii* Vahl	0.39	1.25	1.64
27	*Eleusine indica* (L.) Gaertn.	0.39	1.25	1.64
28	*Emilia sonchifolia* (L.) DC.	0.78	1.25	2.03
29	*Eragrostiella brachyphylla* (Stapf.) Bor	3.53	2.5	6.03
30	*Eragrostis tenella* (L.) P. Beauv. ex Roem. and Schult.	0.39	1.25	1.64
31	*Eriocaulon quinquangulare* L.	5.88	1.25	7.13
32	*Eulophia epidendraea* C.E.C. Fisch.	0.78	1.25	2.03
33	*Euphorbia hirta* L.	1.18	1.25	2.43

34	*Evolvulus alsinoides* (L.) L.	1.18	2.5	3.68
35	*Evolvulus nummularius* (L.) L.	5.10	2.5	7.60
36	*Habenaria viridiflora* (Rottl. ex Sw.) R. Br.	0.39	1.25	1.64
37	*Heliotropium bracteatum* R. Br.	0.78	1.25	2.03
38	*Hemidesmus indicus* (L.) R. Br.	2.75	2.5	5.25
39	*Heteropogon contortus* (L.) P. Beauv. ex Roem. and Schult.	0.39	1.25	1.64
40	*Indigofera trifoliata* L.	0.39	1.25	1.64
41	*Ipomoea pes-tigridis* L.	0.39	1.25	1.64
42	*Kyllinga nemoralis* (J.R. Forst. and G. Forst.) Dandy ex Hutch. and Dalziel	0.78	1.25	2.03
43	*Leucas diffusa* Benth.	0.78	1.25	2.03
44	*Merremia emarginata* (Burm. f.) Hallier f.	1.18	1.25	2.43
45	*Mitracarpus villosus* (Sw.) DC.	5.88	2.5	8.38
46	*Osbeckia zeylanica* Steud. ex Naudin	0.39	1.25	1.64
47	*Panicum psilopodium* Trin.	1.96	1.25	3.21
48	*Pavonia odorata* Willd.	2.75	2.5	5.25
49	*Perotis indica* (L.) Kuntze	0.39	1.25	1.64
50	*Phyllanthus maderaspatensis* L.	0.78	1.25	2.03
51	*Physalis angulata* L.	0.78	1.25	2.03
52	*Plumbago zeylanica* L.	4.31	3.75	8.06
53	*Pupalia lappacea* (L.) Juss.	0.39	1.25	1.64
54	*Pycreus pumilus* (L.) Nees	2.35	3.75	6.10

55	*Scoparia dulcis* L.	0.78	1.25	2.03
56	*Solanum virginianum* L.	0.39	1.25	1.64
57	*Spermacoce hispida* L.	1.18	1.25	2.43
58	*Sporobolus coromandelianus* (Retz.) Kunth	0.39	1.25	1.64
59	*Tephrosia pumila* (Lam.) Pers.	0.78	1.25	2.03
60	*Tephrosia villosa* (L.) Pers.	0.39	1.25	1.64
61	*Theriophonum minutum* (Willd.) Baill.	1.57	1.25	2.82
62	*Tribulus lanuginosus* L.	1.18	1.25	2.43
63	*Tridax procumbens* L.	1.57	1.25	2.82
64	*Utricularia polygaloides* Edgew.	4.31	1.25	5.56
65	*Utricularia scandens* Benj.	1.18	1.25	2.43
66	*Vernonia cinerea* (L.) Less.	0.39	1.25	1.64
	Grand Total	100	100	200

Utricularia polygaloides

Drosera burmannii

Buchanania axillaris

Ziziphus xylopyrus

Carmona retusa

Benkara malabarica

Gloriosa superb (state flower)

Andrographis paniculata

Jatropha gossypifolia

Calotropies gigantia

Phyllanthus madraspatensis

Tribulus terrestris

Fig 3: Some of the rare and important plant species found in the study site.

Medicinal Plants of the Nanmangalam RF

The following medicinal plants are collected from NRF *Corallocarpus epigaeus, Sarcostemma acidum, Cissus quadrangularis, Andrographis paniculata, Gloriosa superba* and *Cleistanthus collinus.*

Botanical Significance of NRF

Nanmangalam RF is home to six endemic species (India and Sri Lanka) of plants. These are *Leucas diffusa*, *Cymbopogon travancorensis*, *Cynodon barberi*, *Chrysopogon asper, Euphorbia corrigioloides* and *Dimeria acutipes*. Among the six, two plants namely *Dimeria acutipes and Cynodon barberi* are strict endemics to Tamil Nadu, with their distribution being restricted only to Chennai and Kanchipuram District.

Some plants that are locally very rare and are drastically disappearing from Chennai and its surrounding areas are also present in considerable numbers at NRF (see table). Five species namely *Drosera indica, Gloriosa superba, Madhuca longifolia, Pseudarthria viscida* and *Santalum album* that are found within NRF are redlisted medicinal plants for South India (Ravikumar, 2000). On other hand we are noticed lots of regeneration of plant species in Nanmangalam RF, this may be due to seed dispersal by frugivores birds in RF.

Table 6. Locally rare plants found in abundance at NRF

S.No	Binomial	S.No	Binomial
1	*Butea monosperma*	15	*Osbeckia zeylanica*
2	*Cadaba fruticosa*	16	*Premna tomentosa*
3	*Capparis brevispina*	17	*Reissantia indica*
4	*Capparis zeylanica*	18	*Santalum album*
5	*Caralluma adscendens*	19	*Sapindus emarginatus*
6	*Chrysopogon asper*	20	*Sarcostemma acidum*
7	*Drosera burmannii*	21	*Strychnos lenticellata*
8	*Drosera indica*	22	*Utricularia caerulea*
9	*Habenaria viridiflora*	23	*Curculigo orchioides*
10	*Iphigenia indica*	24	*Dimeria acutipes*
11	*Lepisanthes tetraphylla*	25	*Dopatrium junceum*
12	*Leucas biflora*	26	*Eulophia epidendraea*
13	*Manilkara hexandra*	27	*Gloriosa superba*
14	*Ochna obtusata*	28	*Tiliacora acuminata*

9.0 Invasive and Alien Species and Management

Alien species are non-native or exotic organisms that occur outside their natural adapted ranges and dispersal potential. Many alien species support our farming and forestry systems in a big way. However, some of the alien species become invasive when they are introduced deliberately or unintentionally outside their natural habitats into new areas where they express the capability to establish, invade and compete with the native species. International Union for Conservation of Nature and Natural Resources (IUCN) defines Invasive alien species as an alien species which becomes established in natural or semi-natural ecosystems or habitat, an agent of change, and threatens native biological diversity. These invasive are widely distributed in all kinds of ecosystems throughout the world, and include all categories of living organisms. Nevertheless, plants, mammals and insects comprise the most common types of invasive alien species in terrestrial environments. The threat to biodiversity due to invasive alien species is considered second only to that of habitat destruction. Invasive species cause loss of biodiversity including species extinctions, and changes in hydrology and ecosystem function. Differences between native and exotic plant species in their requirements and modes of resource acquisition and consumption may cause a change in soil structure, its profile, decomposition, nutrient content of soil, moisture availability, etc.

Invasive species are thus a serious hindrance to conservation and sustainable use of biodiversity, with significant undesirable impacts on the goods and services provided by ecosystems. Biological invasions now operate on a global scale and will undergo rapid increase in this century due to interaction with other changes such as increasing globalization of markets, rise in global trade, travel and tourism. For effective management of invasive species, knowledge about their ecology, morphology, phenology, reproductive biology, physiology and phytochemistry is essential. Generally invasive species put forth profound ecological impacts on biotic communities and

ecological functions of the ecosystems at invaded locations and adversely reduce the biodiversity of ecosystems. Available scientific information (Ramakrishnan, 1991; Williamson, 1996; Rilov and Crooks, 2009) strongly suggests that these invasive species as one of the greatest and significant threat to ecosystem services generated by the native communities. Mechanical, Chemical and biological control programmes are commonly employed to eradicate the exotic plants from the invaded sites. However, the positive utilization of exotic organisms is one of the viable option to manage the menace of the invasive plants. The term positive utilization refers to the use huge biomass of such weeds for human–welfare purposes instead of destroying them either chemically or biologically. Invasive species such as *Lantana camara*, *Parthenium hysterophorus and Prosopis juliflora* were recorded in the Nanmangalam RF, *Lantana camara* found mosly close to the water bodies. These invasive species should be removed in phased manner, and should be monitored regularaly. As management point of view these invasive species management is essential, because these invasive species are suppressing native species regeneration, therefore invasive species management is essential.

Invasive Species Management Choice of control method is based on a number of considerations like the size of the infestation, the amount of vegetation that should be retained, and resources available to the group (both labour and money). Broadly, control methods fall into three categories: 1. Mechanical- Mechanical methods are those that stop the invasive plant from growing and spreading without the use of chemical herbicides. They include hand pulling, cutting, pulling with tools, mowing, etc. 2. Mechanical with application of systemic herbicide 3. Herbicide alone

Lantana camara

Lantana camara L. commonly known as Wild sage is a one among the worst invasive species in the world having the South American origin that threatens the biodiversity of

tropical and sup tropical regions of the world. The native range of *Lantana camara* includes Mexico, parts of the Caribbean, Central America, Venezuela, and Colombia. With the help of frugivorous birds, the shrubs invade natural ecosystems, where they transform the indigenous vegetation into impenetrable thickets of *Lantana*, which diminish natural pasturage, reduce productivity of stock-farming, poison cattle, obstruct access to water sources and plantations, reduce biodiversity and devalue the land (Day *et al.* 2003). An extended competitive advantage gained through the presence of allele chemicals is a plausible explanation for the success and persistence of *L. camara* invasions within certain communities. Potential allelopathic chemicals such as triterpenes have been isolated from *L. camara* and these compounds have been implicated in allel opathic responses (Fischer *et al*. 1994; Langenheim 1994).

It was introduced into India during the 19th century as a garden plant or bio-hedge plant and now it is virtually invaded all the tropical and subtropical forests regions in the country. Especially in the dry tropical forest habitats that constitute the largest forest cover in India is greatly affected by the invasion of *Lantana*.

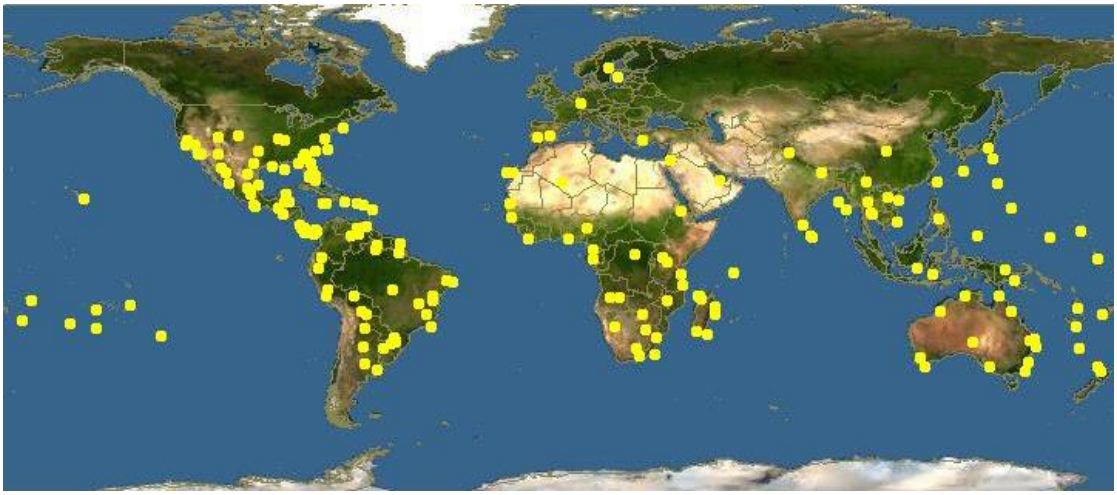

Fig 4. Global distribution of *Lantana camara* (Source:http://www.discoverlife.org/mp/20q)

Prosopis juliflora

Prosopis juliflora (Sw.) Dc. commonly known as Mesquite belong to the family Fabaceae. It is native to Mexico, South America and the Caribbean (Figure 1). It has become established as an invasive weed in tropical regions of Africa, Asia, Australia and elsewhere (Duke, 1983).

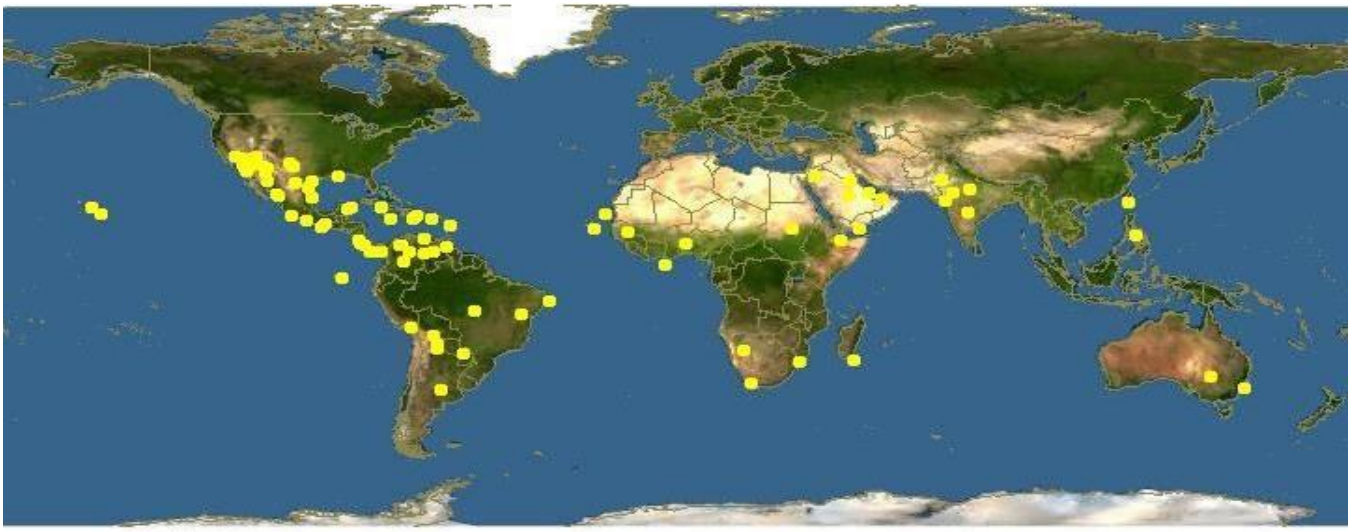

Fig 5. Global distribution of *Prosopis juliflora*(Source: http://www.discoverlife.org/mp/20q)

Description

A large shrub or tree, c. 5 m tall, generally armed with stipular spines. Leaves alternate, bipinnate, with 1-3 pairs of pinnae, rachis 1-8 cm long, prolonged beyond the last pinnae as a soft bristle. Leaflets 10-20 pairs, 7-17 mm long, 2-3 mm broad, entire, oblong, obtuse, sometimes mucronate. Stipules spiny, generally 1.0 cm or less long, in pair. Inflorescence dense axillary pedunculate spikes 4-8.5 cm long, peduncle c. 6-12 mm long. Flowers greenish yellow, pedicel 1 mm. Calyx c. 1 mm long, cup-shaped, 5 toothed, teeth small. Petals 5, free, c. 3 mm long, tip and margin hairy. Stamens 10, free, exserted, c. 4 mm long, anthers tipped with deciduous glands. Pod pedicel late, c. 16-23 cm long, c. 10-12 mm broad, almost straight to semi-circular, light yellow, glabrous, pedicel c. 5-7 mm long. Seeds 10-18, oblong.

10.0 Faunal Diversity

NRF is rich in faunal diversity too, there are about 70 species of birds, around 37 species of butterflies, 7 species of mammals, 14 species of dragonflies and damselflies and 19 species of herpto fauna were recorded during the study period, when compare with earlier study the number of faunal community recorded relative less, it because of duration of the present study was very short.

Mammals

Mammals are not as common as birds, because of the hunting pressures of the past. Mammals such as Grey Mongoose, Indian Palm Squirrel, Blacknaped Hare, House Shrew and Large Bandicoot Rat are common. Other mammals present in the NRF are

the Golden Jackal and Jungle cat which is very rare. Presumably, this area had a good number of Jackal and Jungle cat in the past. The list of Mammals recorded in NRF from direct and indirect evidence is provided in the Table 7.

Table 7. List of mammals recorded in Nanmangalam Reserve Forest

S.No	Common Name	Scientific Name	IUCN Status
1	Grey Mongoose	*Herpestes edwardsii*	Least Concern
2	Blacknaped Hare	*Lepus nigricollis*	Least Concern
3	Indian Palm Squirrel	*Funambulus palmarum*	Least Concern
4	Golden Jackal	*Canis aureus*	Least Concern
5	Jungle Cat	*Felis chaus*	Least Concern
6	House Shrew	*Suncus murinus*	Least Concern
7	Large Bandicoot Rat	*Bandicota indica*	Least Concern

Fig 6. Pellets of Black- Naped hare

Birds

The fauna community of NRF is dominated by birds which are found in good numbers. In the current study, 70 species of birds were recorded in NRF, and the numbers could significantly increase with an increase in the duration of the study.

NRF is one of the interesting bird watching areas of Chennai - Bulbuls (Red Vented and Red Whiskered bulbul), Common Myna's, Yellow Billed Babbler, Large Billed Crow, Loughing Dove, Spotted Dove, Asian Koel, Rufous Treepie, Grey Francolin, Rock Pigeon, Greater Coucal, Snipe Sp., Red Wattled Lapwing, three varieties of Sunbird (Purple, Purple Rumped and Loten's), Black Drongo, Blue Tailed Bee-Eater, Little Green Bee-Eater are very commonly seen all over the RF. Important birds are the Common Babbler, Laughing Dove, Common Wood Shrike, Black Headed, Myna and Red Whiskered Bulbul which are extinct in most parts of Chennai, but are commonly found in NRF.

Other interesting birds are the endangered Eurasian Eagle Owl or Great Horned Owl, Black Shouldered Kite, Indian Night-Jar, Brown Shrike, Rosy Starling, Common Kestrel, Pied Kingfisher, Little Cormorant, White Throated Kingfisher, Common Kingfisher. The list of birds recorded in NRF given in the table 8.

Table.8. List birds recorded in Nanmangalam Reserve Forest

S. No	Common Name	Scientific Name	IUCN status
1.	Common Babbler	*Argya caudate*	Least Concern
2.	Yellow-billed Babbler	*Turdoides affinis*	Least Concern
3.	Coppersmith Barbet	*Psilopogon haemacephala*	Least Concern
4.	Blue-tailed Bee-Eater	*Merops philippinus*	Least Concern
5.	Asian Green Bee-eater	*Merops orientalis*	Least Concern
6.	Red-vented Bulbul	*Pyconotus cafer*	Least Concern
7.	Red-whiskered Bulbul	*Pycnonotus jocosus*	Least Concern
8.	White-browed Bulbul	*Pycnonotus luteolus*	Least Concern
9.	Pied Bushchat	*Saxicola caprata*	Least Concern
10.	Shikra	*Accipiter badius*	Least Concern
11.	Little Cormorant	*Microcarbo niger*	Least Concern
12.	Greater Coucal	*Centropus sinensis*	Least Concern
13.	House Crow	*Corvus splendens*	Least Concern
14.	Large-billed Crow	*Corvus macrorhynchos*	Least Concern

15.	Common Hawk Cuckoo	*Hierococcyx varius*	Least Concern
16.	Grey-bellied Cuckoo	*Cacomantis passerines*	Least Concern
17.	Jacobin Cuckoo	*Clamator jacobinus*	Least Concern
18.	Laughing Dove	*Spilopelia senegalensis*	Least Concern
19.	Eastern Spotted Dove	*Spilopelia chinensis*	Least Concern
20.	Ashy Drongo	*Dicrurus leucophaeus*	Least Concern
21.	Black Drongo	*Dicrurus adsimilis*	Least Concern
22.	Cattle Egret	*Bubulcus ibis*	Least Concern
23.	White-browed Fantail	*Rhipidura aureola*	Least Concern
24.	Black-rumped Flameback	*Dinopium benghalense*	Least Concern
25.	Grey Francolin	*Francolinus pondicerianus*	Least Concern
26.	Little Grebe	*Tachybaptus ruficollis*	Least Concern
27.	Indian Pond Heron	*Ardeola grayii*	Least Concern
28.	Common Hoopoe	*Upupa epops*	Least Concern
29.	Common Iora	Aegithina tiphia	Least Concern
30.	Common Kestrel	*Falco tinnunculus*	Least Concern
31.	Common Kingfisher	*Alcedo atthis*	Least Concern
32.	Pied Kingfisher	*Ceryle rudis*	Least Concern
33.	White-throated Kingfisher	*Halcyon smyrnensis*	Least Concern
34.	Black Kite	*Milvus migrans*	Least Concern
35.	Black-shouldered Kite	*Elanus caeruleus*	Least Concern
36.	Western Koel	*Eudynamys scolopaceus*	Least Concern
37.	Red-wattled Lapwing	*Vanellus indicus*	Least Concern
38.	Yellow-wattled Lapwing	*Vanellus malabaricus*	Least Concern
39.	Ashy-crowned Sparrow Lark	*Eremopterix griseus*	Least Concern

40.	Small Minivet	*Pericrocotus cinnamomeus*	Least Concern
41.	Scaly-breasted Munia	*Lonchura punctulata*	Least Concern
42.	Indian Silver Bill or White-throated Munia	*Euodice malabarica*	Least Concern
43.	Common Myna	*Acridotheres tristis*	Least Concern
44.	Indian Nightjar	*Caprimulgus asiaticus*	Least Concern
45.	Eurasian Golden Oriole	*Oriolus oriolus*	Least Concern
46.	Indian Eagle Owl	*Bubo bengalensis*	Least Concern
47.	Spotted Owlet	*Athene brama*	Least Concern
48.	Rose-ringed Parakeet	*Alexandrinus krameri*	Least Concern
49.	Rock Pigeon or Rock Dove	*Columba livia*	Least Concern
50.	Indian Pitta	*Pitta brachyura*	Least Concern
51.	Ashy Prinia	*Prinia socialis*	Least Concern
52.	Plain Prinia	*Prinia inornata*	Least Concern
53.	Common Quail	*Coturnix coturnix*	Least Concern
54.	Indian Robin	*Saxicoloides fulicata*	Least Concern
55.	Oriental Magpie Robin	*Copsychus saularis*	Least Concern
56.	Indian Roller	*Coracias benghalensis*	Least Concern
57.	Brown Shrike	*Lanius cristatus*	Least Concern
58.	House Sparrow	*Passer domesticus*	Least Concern
59.	Brahminy Starling	*Sturnus pagodarum*	Least Concern
60.	Rosy Starling	*Sturnus roseus*	Least Concern
61.	Asian Openbill Stork	*Anastomus oscitans*	Least Concern
62.	Loten’s Sunbird	*Nectarinia lotenia*	Least Concern
63.	Purple Sunbird	*Nectarinia asiatica*	Least Concern
64.	Purple-rumped Sunbird	*Nectarinia zeylonica*	Least Concern
65.	White-breasted	*Amaurornis phoenicurus*	Least Concern

	waterhen		
66.	Barn Swallow	*Hirundo rustica*	Least Concern
67.	Asian Palm Swift	*Cypsiurus balasiensis*	Least Concern
68.	Little Swift	*Apus affinis*	Least Concern
69.	Common Tailorbird	*Orthotomus sutorius*	Least Concern
70.	Rufous Treepie	*Dendrocitta vagabunda*	Least Concern

Fig 7. Red-vented bulbul nest was observed in the *Lantana* bush

Plate 2. Some of the birds observed in Nanmangalam Reserve Forest

White-throated Kingfisher

Red-vented Bulbul

Little Green Bee-eater

Grey-Heron

Yellow-billed Babbler

Cattle-Egret

Butterflies

Besides vertebrates, NRF is home to fascinating invertebrate life. The large number of butterflies and other insects make the Reserve an enchanting place. The second largest representation of fauna is of the butterflies; the current study recorded about 37 species of butterflies. The commonly see butterflies are Tawny Coster, Common Leopard, Common Grass Yellow, Mottled Emigrant, Angled Castor, Blue Pansy, Dark Grass Blue, Lime Blue, Crimson Rose, Grey Pansy, Common Pierrot, Danaid-Eggfly, Lime Butterfly, Plain Tiger, Common Gull and Common Indian Crow given in table 9.

Table 9. List of Butterflies recorded in Nanmangalam Reserve Forest

S. No	Common Name	Scientific Name	Wildlife Protection Act 1972
1.	Lime Blue	*Chilades laius*	Schudle I Part IV
2.	Pale Grass Blue	*Pseudozizeeria maha*	Schudle I Part IV
3.	Tiny Grass Blue	*Zizula hylax*	Schudle I Part IV
4.	Angled Castor	*Ariadne ariadne*	Schudle I Part IV
5.	Common Caster	*Ariadne merione*	Schudle I Part IV
6.	Tawny Coster	*Acraea violae*	Schudle I Part IV
7.	Crimson Tip	*Colotis danae*	Schudle I Part IV
8.	Common Indian Crow	*Euploea core*	Schudle I Part IV
9.	Danaid Eggfly	*Hypolimnas missippus*	Schudle I Part IV
10.	Great Eggfly	*Hypolimnas bolina*	Schudle I Part IV
11.	Common Emigrant	*Catopsilia Pomona*	Schudle I Part IV
12.	Mottled Emigrant	*Catopsilia pyranthe*	Schudle I Part IV
13.	Common Five-ring	*Yphthima baldus*	Schudle I Part IV
14.	Spotted Small Flat	*Sarangesa purendra*	Schudle I Part IV
15.	Common Gull	*Cepora nerissa*	Schudle I Part IV
16.	Common Jezebel	*Delias eucharis*	Schudle I Part IV
17.	Common Leopard	*Phalanta phalantha*	Schudle I Part IV

18.	Lime Butterfly	*Papilio demoleus*	Schudle I Part IV
19.	Common Mormon	*Papilio polytes*	Schudle I Part IV
20.	Great Orange Tip	*Hebomoia glaucippe*	Schudle I Part IV
21.	Yellow Orange Tip	*Ixias pyrene*	Schudle I Part IV
22.	Blue Pansy	*Junonia orithya*	Schudle I Part IV
23.	Chocolate Pansy	*Junonia iphita*	Schudle I Part IV
24.	Lemon Pansy	*Junonia lemonias*	Schudle I Part IV
25.	Peacock Pansy	*Junonia almanac*	Schudle I Part IV
26.	Yellow Pansy	*Junonia hierta*	Schudle I Part IV
27.	Common Pierrot	*Castalius rosimon*	Schudle I Part IV
28.	Psyche	*Leptosia nina*	Schudle I Part IV
29.	Common Rose	*Pachliopta hector*	Schudle I Part IV
30.	Common Sailor	*Neptis hylas*	Schudle I Part IV
31.	Common Silverline	*Spindasis vulcanus*	Schudle I Part IV
32.	Indian Skipper	*Spialia galba*	Schudle I Part IV
33.	Rice Swift	*Borbo cinnara*	Schudle I Part IV
34.	Blue Tiger	*Tirumala limniace*	Schudle I Part IV
35.	Plain Tiger	*Danaus chrysippus*	Schudle I Part IV
36.	Common Wanderer	*Pareronia valeria*	Schudle I Part IV
37.	Common Grass Yellow	*Eurema hecabe*	Schudle I Part IV

Plate 3. Some of the butterflies observed in Nanmangalam Reserve Forest

Crimson Tip

Peacock Pansy

Common Leopard

Lime Butterfly

Danaid Egg Fly

Common Indian Crow

Dragon and Damselflies

Besides butterflies, the other commonly seen invertebrates are the Dragon and Damselflies. There are about 14 species dragon and damselflies in NRF, some of which may be endangered. These include the Crimson Marsh Glider, Ruddy Marsh Skimmer, Common Picture Wing, Ground Skimmer, Long-Legged Marsh Glider, Wandering Glider, Trumpet Tail and Ditch Jewel. Damselflies such as Golden Dartlets, Coromandel Marsh Dart and Emerald Spreadwing are also found in Nanmangalam RF given table. 10. Apart from butterflies, dragon and damselflies other insects recorded was nursery web spider

(*Dendrolycosa putiana*) and orb-weaver spider (*Argiope aemula*) were recorded in the Nanmangalam RF.

Table .10.Dragonflies and Damselflies recorded in Nanmangalam Reserve Forest

S. No	Common Name	Scientific Name	Wildlife Protection Act 1972
1.	Coromandel Marsh Dart	*Ceriagrion coromandelianum*	Schudle I Part IV
2.	Golden Dartlet	*Ischnura aurora*	Schudle I Part IV
3.	Grass Dartlet	*Pseudagrion decorum*	Schudle I Part IV
4.	Crimson Marsh Gligder	*Trithemis aurora*	Schudle I Part IV
5.	Long-legged Marsh Glider	*Trithemis pallidinervis*	Schudle I Part IV
6.	Wandering Glider	*Pantala flavescens*	Schudle I Part IV
7.	Green Marsh Hawk	*Orthetum sabina*	Schudle I Part IV
8.	Ditch Jewel	*Brachythemis contaminata*	Schudle I Part IV
9.	Common Picture-wing	*Rhyothemis variegata*	Schudle I Part IV
10.	Ground Skimmer	*Diplocodes trivialis*	Schudle I Part IV
11.	Red marsh Skimmer	*Crocothemis servilla*	Schudle I Part IV
12.	Emerald Spreadwing	*Lestes elatus*	Schudle I Part IV
13.	Back Marsh Trotter	*Tramea limbata*	Schudle I Part IV
14.	Trumpet-tail	*Acisoma panorpoides*	Schudle I Part IV

Herpto Fauna

Common amphibians found in NRF are frogs and toads. The NRF is home to several amphibians such as the Common Indian Toad, Jerdon's Bull Frog, Indian Pond Frog, Skipper Frog, Common Tree Frog and Paddy Field Frog.

Fifty percent of Indian reptilian species are snakes. There is no detailed list of reptiles available for NRF. The current study recorded Garden Lizards, Indian Fan-throated Lizards, Common Skink and Common Monitor Lizard. Apart from lizards, snakes such as the Rat Snake, Indian Cobra, Common Vine Snake and Checkered Keelback were also recorded (See table below). The Indian Fanthroated Lizards are plenty in number within the NRF given in table11.

Table. 11. List of Herpto fauna recorded in Nanmangalam Reserve Forest

S. No	Common Name	Scientific Name	Wildlife Protection Act 1972
1.	Common Indian Toad	*Bufo melanosticus*	Schudle I Part II
2.	Common Tree Frog	*Polypedates maculates*	Schudle I Part II
3.	Indian Pond Frog	*Euphlyctis hexadactylus*	Schudle I Part II
4.	Indian Skipper Frog	*Euphlyctis cyanophlyctis*	Schudle I Part II
5.	Jerdon's Bull Frog	*Hoplobatrachus crassus*	Schudle I Part II
6.	Paddy Field Frog	*Fejervarya limnocharis*	Schudle I Part II
7.	Indian Burrowing Frog	*Tomopterna breviceps*	Schudle I Part II
8.	Indian Cobra	*Naja naja*	Schudle I Part II
9.	Rat Snake	*Ptyas mucosus*	Schudle I Part II
10.	Checkered Keelback	*Xenochrophis piscator*	Schudle I Part II
11.	Common Vine Snake	*Ahaetulla nasutus*	Schudle I Part II
12.	Garden Lizard	*Calotes versicolor*	Schudle I Part II
13.	Indian Fan-throated Lizard	*Sitana ponticeriana*	Schudle I Part II
14.	Spotted Gecko	*Hemidactylus brooki*	Schudle I Part II
15.	Common Monitor Lizard	*Varanus bengalensis*	Schudle I Part II

16.	Common Skink	*Mabuya carinatus*	Schudle I Part II
17.	Little Skink	*Mabuya macularius*	Schudle I Part II
18.	Star Tortise	*Geochelone elegans*	Schudle I Part II
19.	Fresh water Turtle	*Lissemysnpunctata*	Schudle I Part II

Plate. 4. Some Herpto Fauna recorded in the Nanmangalam Reserve Forest

Bronzed Frog

Indian Bull Frog

Skipper Frog

Garden Lizard

Fishes

The term "fish" most precisely describes any non-tetra pod craniates (i.e. an animal with a skull and in most cases a backbone) that have gills throughout life and whose limbs, if any, are in the shape of fins. Unlike groupings such as birds or mammals, fish are not a single clade but a paraphyletic collection of taxa, including hagfishes, lampreys, sharks and rays, ray finned fish, coelacanths, and lungfish. A typical fish is ectothermic, has a

streamlined body for rapid swimming, extracts oxygen from water using gills or uses an accessory breathing organ to breathe atmospheric oxygen, has two sets of paired fins, usually one or two (rarely three) dorsal fins, an anal fin, and a tail fin, has jaws, has skin that is usually covered with scales, and lays eggs. During the assessment we have recorded two species of fishes in Nanmangalam RF namely Spotted Snakehead, Mozambique Tilapia (invasive species), based on secondary information from the forest field staff.

Table: 12. List of Fishes recorded in Nanmangalam RF

S. No	Common Name	Scientific Name	IUCN status
1.	Spotted snakehead	*Channa punctatus*	Least Concern
2.	BlackTilapia	*Oreochromis placidus*	Vulnurable

11.0 Nature Trail

Continued presernce and use by humans has led to the formation of a number of paths within the RF. In view of the high representation of Bulbuls in NRF, the trails have been designated as Red Whiskered Bulbul (main trail), Red Vented Bulbul trail and White-Browed Bulbul trail. The length of the trails varies from 2 – 4km and they run through various habitats within the RF such as grasslands, dense scrub, meadows and plantations. This RF has diverse habitats such as hillock, plains and abandoned quarries Vegetation is of dense scrub. Shrubs such as ***Flacourtia indica, Atalantia monophylla*** are very common seen. ***Stenosiphonium russellianum***, a close relative to the genus ***Strobilanthus*** (the genus of Kurinji flowers) which produces blue colored flowers gregariously along the slopes and foot hills during January and can be seen until February. It supports the survival large number of bees, butterflies and sunbirds. Abandoned quarries give home to many freshwater creatures. Aquatic plants such as ***Typha angustata, Hydrilla verticellata, Aponogeton natans, Cyperus*** sp., and Chara.., are found in the quarries. Fresh water Turtles, Water snake, Jerdon's Bull Frog, Indian Burrowing Frog, Skipper Frog and birds such as Pied king fisher, Little cormorant, White breasted water hen, Red wattle lapwing and Great horned owl or Eurasian Eagle Owl are also found in this area.

Fig 8. A view of Nature Trail in Nanmangalam RF

The habitat is of hillock and quarry intervened by the main trail. Vegetation constitutes of thick scrub with sparsely distributed trees such *as* ***Lannea coromandelica, Albizia lebbeck*** **and** ***Ficus benghalensi, Tectona grandis, Acacia ferruginea, A.leucoplea*** are found in this area. The hillocks within these grids possess the highest elevation of 70 meters ASL. A rare terrestrial orchid Eulophia epidendraea is present in abundance along the western slope of the hillock adding further conservation value to the habitat. Birds such as Indian **Pitta, Common Iora, Eurasian Golden Oriole, Pied Bushchat, Red-Vented Bulbul, Red Whiskered Bulbul, Yellow-Billed Babbler, White-Browed Bulbul, Pied Kingfisher and Little Cormorant and rare birds like Rosy Starling,** a winter visitor, were also recorded in this area.

12.0 Biodiversity Management Plan

During the construction period there will be disturbance to nature such as Air Pollution, Noise Pollution and Vibration this will cause adverse impact on biodiversity. Therefore, preventive measure needs to be taken to avoid, minimize, mitigate and compensate the impact. In case of removing the tree which come across the metro corridor, that needs to be transplanted or replaced. Also CMRL will explore the possibility of installing bird divertors along the project area.

Air Pollution

Construction work of the metro rail has impact on the air quality at station and at depot only since metro alignment is constructed at an average depth of 18-20 metres. In the previous chapter, the existing conditions of air quality along the alignment are described. The monitoring results of pollutants such as NO2 , SO2 and CO are much below the national standards (NAAQS, CPCB), the dust concentrations monitored are 2.0 – 2.4 times higher than the standard value. Hence, dust could be the problem when the project is under construction. Any development can have associated health impact that can result directly from changes to the biophysical environment or indirectly as the result of other changes caused by the project. The air pollutants such as particulate matter, sulphur dioxides and nitrogen oxide have adverse impact on human health. The impact of air pollution aggravates bronchitis, respiratory diseases, emphysema, cardiovascular diseases and eye irritation. However, the air pollution during construction is localized and only around the station construction sites only.

Noise Pollution

The major sources of noise pollution during construction are movement of vehicles for transportation of construction material and the construction machinery/equipment at the construction site. No major impacts are anticipated due to noise pollution as the major construction works are underground only. Noise levels at source have been forecasted at various distance as reproduced. Exposure to noise may lead to complete hearing loss, tension, fatigue, fast pulse/ respiration rates, dizziness & loss of balance, anger, irritation & in extreme case nervousness. Construction of noise barriers, such as temporary walls between noisy activities reduces noise. Vegetation cover also reduces the noise level.

Vibration Impact

TBM is the worldwide accepted machine having less impact of vibration. Human response to ground-borne vibration is influenced by amplitude, duration and frequency and are subjective in nature. According to the U.S. Department of Transportation, (1998) the perception threshold of humans for particle velocity is about 0.04 mm/s (65 VdB with reference 1e-6 inch/sec). For a person in their residence, the lower threshold for annoyance is 72 VdB (FTA 2006). The vibration may cause the impact on breeding birds or migratory birds.

Air Pollution Control Measures

During the construction period, the impact on air quality will be mainly due to increase in Suspended Particulate Matter (SPM) emission from vehicles and construction machinery. Though an air quality during construction shows insignificant impact, nevertheless certain mitigation measures which shall be adopted to reduce the air pollution are presented below:

- The contractor shall take all necessary precautions to minimise fugitive dust emissions from operations involving excavation, grading, and clearing of land and disposal of waste. He shall not allow emissions of fugitive dust from any transport during handling of materials, construction or storage activity. The emission should not remain visible in atmosphere beyond the property line of emission source for any prolonged period of time without notification to the Employer.
- The Contractor shall use construction equipment to minimise or control of air pollution. He shall maintain evidence of design and equipment to make these available for inspection by Employer.
- Contractor's transport vehicles and other equipment shall conform to emission standards fixed by Statutory Agencies of Government of India or the State Government from time to time. The Contractor shall carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms.
- The Contractor shall use cover for materials of dust generating like debris and soil being transported from construction sites. All trucks carrying loose material should

be covered and loaded with sufficient free- board to avoid.

- Contractor shall install barriers around the open construction sites before commencing the work.
- The temporary dumping areas shall be maintained by the Contractor at all times until excavate is re-utilised for backfilling wherever necessary or as directed by Employer. Dust control activities shall continue even during any work stoppage.
- The Contractor shall place material in a manner that will minimize dust production. Material shall be wetted each day, to minimize dust production. During dry weather, dust control measures must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter.
- The Contractor shall sprinkle water at construction sites to suppress dust, during handling of excavation soil or debris or during demolition. The Contractor will make water sprinklers, water supply and water delivering equipment available at any time that it is required for dust control use. Dust screens will be used, as feasible when additional dust control measures are needed especially where the work is near sensitive receptors.
- The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt.

Noise Control Measures

- There will be an increase in noise level during the construction and operation of the Metro corridors. However, noise levels in the core city are expected to go down. The increases in levels are marginal; hence local population will not be adversely affected.
- However the exposure of workers to high noise levels especially, near the engine, vent shaft etc. need to be minimized. This could be achieved by job rotation to the extent possible.

Automation

- Construction of permanent and temporary noise barriers,
- Re-route and regulate the traffic, a main source of noise,
- Use electric instead of diesel powered equipment,

- Use hydraulic tools instead of pneumatic tools,
- Acoustic enclosures should be provided for individual noise generating construction equipment,
- Scheduling of truck loading, unloading and hauling operation,
- Proper operation and maintenance of the construction vehicles and equipment would keep them within noise limit,
    - Schedule work to avoid simultaneous activities,
    - Anti drumming floor and noise absorption material,
    - Low speed compressor, blower and air conditioner,
    - Mounting of under frame equipment on anti-vibration pad,
    - Smooth and gradual control of door,
    - Provision of GRP baffle on the via-duct for elimination of noise transmission,
    - Provision of sound absorbing material in the supply duct and return grill of air conditioner,
    - Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes, and
    - Sound proof compartments/ control rooms etc.
    - The workers employed in high noise level area could be employed in low noise level areas and vice-versa from time to time. Automation of equipment and machineries, wherever possible, should be done to avoid continuous exposure of workers to noise. At work places, where automation of machineries is not possible or feasible, the workers exposed to noise should be provided with protective devices. Special acoustic enclosures should be provided for individual noise generating equipment, wherever possible.
    - Workers in those sections where periodic adjustment of equipment/machinery is necessary, should be provided with sound proof control rooms so that exposure to higher noise level is reduced. Effective measures should be taken during the construction phase to reduce the noise from various sources. The noise from air compressor can be reduced by fitting exhaust and intake mufflers. Noise proof barriers will be provided on the construction boundary near the residential area.

- Noise level from loading and unloading of construction materials can be reduced by usage of various types of cranes and placing materials on sand or sandy bag beds. The ballast- less track is supported on two layers of rubber pads to reduce track noise and ground vibrations. In addition, baffle walls as parapets will be constructed at up to the rail level so as to reduce sound levels.

Vibration Control Measures

An actual vibration impact shall be carried out prior to the start of construction and during the construction on the basis of detailed soil investigation and TBM activities involved. Detailed geotechnical investigation is required prior to the tunnel construction. By adopting good construction practices, generation of vibration will be controlled during construction and operation. The preventive measure should be taken to minimize the impact on Biodiversity during the construction phase.

Following measures to be taken during construction period, the contractor shall prepare a monitoring scheme prior to construction at such locations.

- Detailed vibration investigation should be carried out prior to construction at locations where the alignment is close to forest area.
- Continuous vibration monitoring equipment shall be installed during construction.
- Vibration monitoring shall also be conducted inside as well as on the top of the building mainly for old structures and heritage buildings.
- Proper vibration mitigation measures to be taken during construction of tunnels and also during operation of metro rail.
- Pre-construction structural integrity inspections of historic and sensitive structures.
- The local residence staying in the buildings close to the proposed metro rail alignment shall be informed about the vibrations and to vacate the location if needed.
- Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.
- Inform the public about the project and potential vibration-related consequences, monitor and record vibration from the activities for sensitive receptors.

- Vibration emanates from rail - wheel interaction and the same can be reduced by minimizing surface irregularities of wheel and rail, improving track geometry, providing elastic fastenings, and separation of rail seat assembly from the concrete plinth with insertion of resilient and shock absorbing pad.
- While designing the track structure for Mass Rapid Transit System all the above points have been taken into consideration in the following ways:
- The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used.
- The lower vibration will be achieved by providing of bolster less type bogies having secondary air spring.

Impact on Ecology

The Project will seek to minimize impacts on notable species and loss, fragmentation, alteration, disturbance and disruption of sensitive habitats. The approach to be taken is outlined throughout this Metro area. A principal management tool in this will be the use of Biodiversity Specialists. A minimum of one Biodiversity Specialist will be employed for every lot / spread of metro construction. All Biodiversity Specialists will be appropriately skilled for undertaking site supervision and species relocations where required. The Biodiversity Specialists contracted will identify and map potentially sensitive habitats (including potential notable species habitat) along the spread ahead of any works. Habitats will be mapped in sufficient detail that the locations of notable plant (and where practical animal) species (including rare and endangered species) are clearly marked. Mitigation will be applied in all areas where sensitive habitats are identified, The maps will be used to monitor mitigation effectiveness. Where any such habitats or species present impacts will be mitigated as outlined in the metro area

Necessary mitigation measure must be undertaken to reduce the indirect impact of the project to the nearby forest areas and overall ecology. The indirect impact may be due to release of contaminated, polluted or untreated water, debris, or other materials particular to the kind of the project.

Suggested mitigation measures

- 1. Avenue plantation all along the project location should be done and mainly consist of native plant species.
- 2. The water effluent discharge should be as per state guidelines.
- 3. The project proponent must undertake plantation drives to improve native plant diversity of the region

Establishing Green Belt

During the construction time some trees may be removed, therefore establishing green belt is essential. The total area available for plantation has been divided into different zones to prepare a comprehensive plantation strategy. According to the flora diversity and the nature of the existing vegetation along the Reserve Forest, it is suggested to plant Tropical Dry Evergreen tree (Native species) species. On the other hand removal of invasive species mainly *Prosopis juliflora* is foremost important, after removal of *Prosopis*, those area would be planted by native tree species which is recommended. Since the metro rail corridor coming along the RF, hence developing green belt is essential to observe the air pollution in that area. The list of plant species recommended for planting are as follows:

Large tree	Medium Tree
Wrightia tinctoria	*Acacia auriculiformis*
Albizia lebbeck	*Canthium dicoccum*
Pongamia pinnata	*Buchanania axillaris*
Syzygium cumini	*Calophyllum inophyllum*
Terminalia cuneata	*Diospyros Montana*
Diospyros malabarica	*Psydrax dicoccos*
Madhuca longifolia	*Sapindus emarginatus*
Limonia acidissima	*Madhuca indica*
Azadirachta indica	*Anogeissus latifolia*
Pterocarpus santalinus	*Diospyros chloroxylon*
Lannea coromandelica	*Litsea glutinosa*
Manilkara hexandra	*Cassia fistula*
Terminalia chebula	

Outreach / Nature education

Outreach/Nature education programme is very important, to aware about the importance Nanmangalam RF. Already well established an interpretation centre is available. This centre can emphasize the importance and conservation issues of RF and the ecosystem services derived from such ecosystems. Audiovisual centre and museum are also important components of the centre. This can be open for children, students and public. The centre can also organize and conduct camps, workshops and seminars targeting different segments of the society. This centre will also provide information to tourists.

Signage board is another important component for the outreach programme, already some signage boards installed, this may improved further to attract public to aware of the Nanmangalam RF, further developing field guides, nature trails which may attract local public to visit the RF.

Possiblity of implementing the additional mitigation measures will be analysed during construction stage to minimize the residual impacts on biodiversity.

13.0 Summary and Conclusion

A study to assess the biodiversity of Nanmangalam RF, apart from assessing the habitat diversity and quality of the RF, the study enumerated the flora and fauna of the RF.Results indicate that the Nanmangalam RF harbours a notable diversity of flora and fauna, with the potential of functioning as an in situ conservation area for plants. The merit of the RF is further enhanced by the presence of a sizeable number of endemics and endangered organisms. The Metro rail phase 2 and corridor 5 is proposed in the boundary of the Nanmangalam Reserve Forest, since the metro rail activity will take place in the boundary of the RF,therefore the impact may be very minimal, that has to be monitor during the construction phase, every quarter the impact report should be submitted to concern authority of CMRL. A senior ecologist may be appointed to monitor the day to day activities in the corridor 5, phase 2 area metro.

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APPENDICES

1.0 List plants recorded in Nanmangalam Reserve Forest

S.No	Species	Family	Habit
1	*Abrus precatorius*	Fabaceae	Climber
2	*Abutilon hirtum*	Malvaceae	Shrub
3	*Abutilon indicum*	Malvaceae	Shrub
4	*Acacia auriculiformis*	Mimosaceae	Tree
5	*Acacia caesia*	Caesalpiniaceae	Shrub-Stragglar
6	*Acacia ferruginea*	Mimosaceae	Tree
7	*Acacia leucophloea*	Mimosaceae	Tree
8	*Acacia planifrons*	Mimosaceae	Tree
9	*Acalypha indica*	Euphorbiaceae	Herb
10	*Acalypha lanceolata*	Euphorbiaceae	Herb
11	*Acanthospermum hispidum*	Asteraceae	Herb
12	*Achyranthes aspera*	Amaranthaceae	Herb
13	*Aerva lanata*	Amaranthaceae	Herb
14	*Aeschynomene aspera*	Fabaceae	Herb
15	*Aeschynomene indica*	Fabaceae	Herb
16	*Agave angustifolia*	Agavaceae	Shrub
17	*Ageratum conyzoides*	Asteraceae	Herb
18	*Albizia lebbeck*	Mimosaceae	Tree
19	*Allmania nodiflora*	Amaranthaceae	Herb
20	*Allophylus cobbe*	Sapindaceae	Shrub-Straggler
21	*Alloteropsis cimicina*	Poaceae	Herb-Grass
22	*Alternanthera sessilis*	Amaranthaceae	Herb

S.No	Species	Family	Habit
23	*Alternanthera tenella*	Amaranthaceae	Herb
24	*Alysicarpus monilifer*	Fabaceae	Herb
25	*Alysicarpus ovalifolius*	Fabaceae	Herb
26	*Amaranthus spinosus*	Amaranthaceae	Herb
27	*Amaranthus viridis*	Amaranthaceae	Herb
28	*Ammania baccifera*	Lythraceae	Herb
29	*Andrographis paniculata*	Acanthaceae	Herb
30	*Andropogon pumilus*	Poaceae	Herb-Grass
31	*Anisomeles indica*	Lamiaceae	Undershrub
32	*Anisomeles malabarica*	Lamiaceae	Shrub
33	*Annona eticulate*	Annonaceae	Tree-Small
34	*Anogeissus latifolia*	Combretaceae	Tree
35	*Apluda mutica*	Poaceae	Herb-Grass
36	*Aponogeton natans*	Aponogetonaceae	Herb
37	*Aristida adscensionis*	Poaceae	Herb-Grass
38	*Aristida hystrix*	Poaceae	Herb-Grass
39	*Aristida setacea*	Poaceae	Herb-Grass
40	*Asparagus racemosus*	Liliaceae	Liana
41	*Asystasia gangetica*	Acanthaceae	Herb
42	*Atalantia monophylla*	Rutaceae	Tree-Small
43	*Axonopus compressus*	Poaceae	Herb-Grass
44	*Azadirachta indica*	Meliaceae	Tree
45	*Bacopa floribunda*	Scrophulariaceae	Herb
46	Barringtonia acutangula (L.) Gaertn.	Barringtoniaceae	Tree
47	*Barleria prionitis*	Acanthaceae	Undershrub

S.No	*Species*	Family	Habit
48	*Basilicum polystachyon*	Lamiaceae	Herb
49	*Bauhinia racemosa*	Caesalpiniaceae	Tree-Small
50	*Benkara malabarica*	Rubiaceae	Shrub
51	*Blepharis maderaspatensis*	Acanthaceae	Herb
52	*Blepharis repens*	Acanthaceae	Herb
53	*Blumea aurita*	Asteraceae	Herb
54	*Blumea oblique*	Asteraceae	Herb
55	*Boerhavia diffusa*	Nyctaginaceae	Herb
56	*Boerhavia erecta*	Nyctaginaceae	Herb
57	*Borassus flabellifer*	Arecaceae	Tree
58	*Bothriochloa pertusa*	Poaceae	Herb-Grass
59	*Brachiaria distachya*	Poaceae	Herb-Grass
60	*Brachiaria remota*	Poaceae	Herb-Grass
61	*Breynia vitis-idaea*	Euphorbiaceae	Shrub
62	*Buchanania axillaris*	Anacardiaceae	Tree
63	*Bulbostylis barbata*	Cyperaceae	Herb-Sedge
64	*Butea monosperma*	Fabaceae	Tree
65	*Cadaba fruticosa*	Capparidaceae	Shrub
66	*Cajanus scarabaeoides*	Fabaceae	Climber
67	*Calotropis eticulat*	Asclepiadaceae	Shrub
68	*Canavalia virosus*	Fabaceae	Climber
69	*Canscora eticulates*	Gentianaceae	Herb
70	*Cansjera rheedii*	Opiliaceae	Shrub-Straggler
71	*Canthium dicoccum*	Rubiaceae	Tree-Small
72	*Canthium parviflorum*	Rubiaceae	Shrub

S.No	*Species*	Family	Habit
73	*Capparis brevispina*	Capparidaceae	Shrub
74	*Capparis sepiaria*	Capparidaceae	Shrub-Straggler
75	*Capparis zeylanica*	Capparidaceae	Shrub-Straggler
76	*Caralluma adscendens*	Asclepiadaceae	Herb
77	*Cardiospermum halicacabum*	Sapindaceae	Climber
78	*Carissa spinarum*	Apocynaceae	Shrub
79	*Carmona retusa*	Boraginaceae	Shrub
80	*Cassia absus*	Caesalpiniaceae	Herb
81	*Cassia auriculata*	Caesalpiniaceae	Shrub
82	*Cassia fistula*	Caesalpiniaceae	Tree
83	*Cassia hirsute*	Caesalpiniaceae	Undershrub
84	*Cassia mimosoides*	Caesalpiniaceae	Herb
85	*Cassia occidentalis*	Caesalpiniaceae	Undershrub
86	*Cassia pumila*	Caesalpiniaceae	Herb
87	*Cassia roxburghii*	Caesalpiniaceae	Tree
88	*Cassia siamea*	Caesalpiniaceae	Tree
89	*Cassia tora*	Caesalpiniaceae	Undershrub
90	*Cassytha filiformis*	Lauraceae	Parasite
91	*Catharanthus roseus*	Apocynaceae	Herb
92	*Catunaregam spinosa*	Rubiaceae	Shrub
93	*Cereus pterogonus*	Cactaceae	Shrub
94	*Chloris barbata*	Poaceae	Herb-Grass
95	*Chloris eticul*	Poaceae	Herb-Grass
96	*Chlorophytum tuberosum*	Liliaceae	Herb

S.No	Species	Family	Habit
73	*Capparis brevispina*	Capparidaceae	Shrub
74	*Capparis sepiaria*	Capparidaceae	Shrub-Straggler
75	*Capparis zeylanica*	Capparidaceae	Shrub-Straggler
76	*Caralluma adscendens*	Asclepiadaceae	Herb
77	*Cardiospermum halicacabum*	Sapindaceae	Climber
78	*Carissa spinarum*	Apocynaceae	Shrub
79	*Carmona retusa*	Boraginaceae	Shrub
80	*Cassia absus*	Caesalpiniaceae	Herb
81	*Cassia auriculata*	Caesalpiniaceae	Shrub
82	*Cassia fistula*	Caesalpiniaceae	Tree
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84	*Cassia mimosoides*	Caesalpiniaceae	Herb
85	*Cassia occidentalis*	Caesalpiniaceae	Undershrub
86	*Cassia pumila*	Caesalpiniaceae	Herb
87	*Cassia roxburghii*	Caesalpiniaceae	Tree
88	*Cassia siamea*	Caesalpiniaceae	Tree
89	*Cassia tora*	Caesalpiniaceae	Undershrub
90	*Cassytha filiformis*	Lauraceae	Parasite
91	*Catharanthus roseus*	Apocynaceae	Herb
92	*Catunaregam spinosa*	Rubiaceae	Shrub
93	*Cereus pterogonus*	Cactaceae	Shrub
94	*Chloris barbata*	Poaceae	Herb-Grass
95	*Chloris eticul*	Poaceae	Herb-Grass
96	*Chlorophytum tuberosum*	Liliaceae	Herb

S.No	Species	Family	Habit
97	*Chrysopogon asper*	Poaceae	Herb-Grass
98	*Chrysopogon fulvus*	Poaceae	Herb-Grass
99	*Cissampelos pareira*	Menispermaceae	Climber
100	*Cissus quadrangularis*	Vitaceae	Shrub-Straggler
101	*Cissus vitiginea*	Vitaceae	Liana
102	*Cleistanthus collinus*	Euphorbiaceae	Shrub
103	*Cleome aspera*	Cleomaceae	Herb
104	*Cleome rutidosperma*	Cleomaceae	Herb
105	*Cleome viscose*	Cleomaceae	Herb
106	*Clitoria ternatea*	Fabaceae	Climber
107	*Coccinia grandis*	Cucurbitaceae	Climber
108	*Coldenia procumbens*	Boraginaceae	Herb
109	*Combretum albidum*	Combretaceae	Liana
110	*Commelina eticulat*	Commelinaceae	Herb
111	*Commelina benghalensis*	Commelinaceae	Herb
112	*Corallocarpus epigaeus*	Cucurbitaceae	Climber
113	*Corchorus aestuans*	Tiliaceae	Herb
114	*Cordia eticul*	Cordiaceae	Tree
115	*Crateva adansonii*	Capparidaceae	Tree-Small
116	*Crinum viviparum*	Amaryllidaceae	Herb
117	*Crotalaria hebecarpa*	Fabaceae	Herb
118	*Crotalaria juncea*	Fabaceae	Undershrub
119	*Crotalaria medicaginea*	Fabaceae	Herb
120	*Crotalaria pallida*	Fabaceae	Undershrub
121	*Crotalaria eticulat*	Fabaceae	Herb

S.No	Species	Family	Habit
122	*Crotalaria retusa*	Fabaceae	Undershrub
123	*Crotalaria verrucosa*	Fabaceae	Undershrub
124	*Croton bonplandianum*	Euphorbiaceae	Herb
125	*Ctenolepis garcinii*	Cucurbitaceae	Climber
126	*Cucumis melo*	Cucurbitaceae	Climber
127	*Curculigo orchioides*	Hypoxidaceae	Herb
128	*Cyanotis eticulate*	Commelinaceae	Herb
129	*Cyanotis cristata*	Commelinaceae	Herb
130	*Cymbopogon travancorensis*	Poaceae	Herb-Grass
131	*Cynodon barberi*	Poaceae	Herb-Grass
132	*Cynodon dactylon*	Poaceae	Herb-Grass
133	*Cyperus clarkei*	Cyperaceae	Herb-Sedge
134	*Cyperus distans*	Cyperaceae	Herb-Sedge
135	*Cyperus iria*	Cyperaceae	Herb-Sedge
136	*Cyperus rotundus*	Cyperaceae	Herb-Sedge
137	*Cyrtococcum trigonum*	Poaceae	Herb-Grass
138	*Dactyloctenium aegyptium*	Poaceae	Herb-Grass
139	*Dalbergia lanceolaria*	Fabaceae	Tree
140	*Dalbergia sissoo*	Fabaceae	Tree
141	*Datura innoxia*	Solanaceae	Undershrub
142	*Datura metal*	Solanaceae	Undershrub
143	*Delonix regia*	Caesalpiniaceae	Tree
144	*Dentella repens*	Rubiaceae	Herb
145	*Desmodium tortuosum*	Fabaceae	Undershrub
146	*Desmodium triflorum*	Fabaceae	Herb

S.No	Species	Family	Habit
147	*Desmostachya bipinnata*	Poaceae	Herb-Grass
148	*Dicanthium armatum*	Poaceae	Herb-Grass
149	*Dicerma biarticulatum*	Fabaceae	Herb
150	*Dichanthium caricosum*	Poaceae	Herb-Grass
151	*Dichrostachys cinerea*	Mimosaceae	Tree-Small
152	*Digitaria ciliaris*	Poaceae	Herb-Grass
153	*Dimeria acutipes*	Poaceae	Herb-Grass
154	*Dioscorea pentaphylla*	Dioscoreaceae	Climber
155	*Diospyros chloroxylon*	Ebenaceae	Tree
156	*Diospyros ferrea*	Ebenaceae	Shrub
157	*Diospyros melanoxylon*	Ebenaceae	Tree-Small
158	*Diplocyclos palmatus*	Cucurbitaceae	Climber
159	*Dipteracanthus eticulate*	Acanthaceae	Herb
160	*Dodonaea viscosa*	Sapindaceae	Shrub
161	*Dolichandrone eticul*	Bignoniaceae	Tree
162	*Dopatrium junceum*	Scrophulariaceae	Herb
163	*Drosera burmannii*	Droseraceae	Herb
164	*Drosera indica*	Droseraceae	Herb
165	*Drypetes sepiaria*	Euphorbiaceae	Tree-Small
166	*Ecbolium viride*	Acanthaceae	Undershrub
167	*Eclipta prostrata*	Asteraceae	Herb
168	*Ehretia pubescens*	Cordiaceae	Tree-Small
169	*Eleusine indica*	Poaceae	Herb-Grass
170	*Emilia sonchifolia*	Asteraceae	Herb

S.No	Species	Family	Habit
171	*Enicostema axillare*	Gentianaceae	Herb
172	*Enterolobium cyclocarpum*	Mimisaceae	Tree
173	*Enteropogon monostachyos*	Poaceae	Herb-Grass
174	*Epaltes divaricata*	Asteraceae	Herb
175	*Eragrostiella bifaria*	Poaceae	Herb-Grass
176	*Eragrostiella brachyphylla*	Poaceae	Herb-Grass
177	*Eragrostis gangetica*	Poaceae	Herb-Grass
178	*Eragrostis macilenta*	Poaceae	Herb-Grass
179	*Eragrostis nutans*	Poaceae	Herb-Grass
180	*Eragrostis tenella var. insularis*	Poaceae	Herb-Grass
181	*Eragrostis tenella var. tenella*	Poaceae	Herb-Grass
182	*Eragrostis unioloides*	Poaceae	Herb-Grass
183	*Eragrostis eticul*	Poaceae	Herb-Grass
184	*Eriocaulon quinquangulare*	Eriocaulaceae	Herb
185	*Erythrina suberosa*	Fabaceae	Tree
186	*Eucalyptus tereticornis*	Myrtaceae	Tree
187	*Eulophia epidendraea*	orchidaceae	Herb
188	*Euphorbia antiquorum*	Euphorbiaceae	Shrub
189	*Euphorbia corrigioloides*	Euphorbiaceae	Herb
190	*Euphorbia hirta*	Euphorbiaceae	Herb
191	*Euphorbia indica*	Euphorbiaceae	Herb
192	*Euphorbia tirucalli*	Euphorbiaceae	Shrub
193	*Evolvulus alsinoides*	Convolvulaceae	Herb-Creeper
194	*Evolvulus nummularius*	Convolvulaceae	Herb-Creeper

S.No	Species	Family	Habit
195	*Ficus amplissima*	Moraceae	Tree
196	*Ficus benghalensis*	Moraceae	Tree
197	*Ficus hispida*	Moraceae	Shrub
198	*Ficus racemosa*	Moraceae	Tree
199	*Ficus religiosa*	Moraceae	Tree
200	*Fimbristylis argentea*	Cyperaceae	Herb-Sedge
201	*Fimbristylis dichotoma*	Cyperaceae	Herb-Sedge
202	*Fimbristylis miliacea*	Cyperaceae	Herb-Sedge
203	*Fimbristylis ovata*	Cyperaceae	Herb-Sedge
204	*Flacourtia indica*	Flocourcaceae	Shrub
205	*Geniosporium tenuiflorum*	Lamiaceae	Herb
206	*Glinus oppositifolius*	Molluginaceae	Herb
207	*Gliricidia sepium*	Fabaceae	Tree-Small
208	*Gloriosa superba*	Liliaceae	Climber
209	*Glycosmis mauritiana*	Rutaceae	Shrub
210	*Gmelina asiatica*	Verbenaceae	Shrub
211	*Gomphrena serrata*	Amaranthaceae	Herb
212	*Grewia eticul*	Tiliaceae	Shrub
213	*Grewia orientalis*	Tiliaceae	Shrub-Straggler
214	*Guazuma ulmifolia*	Sterculiaceae	Tree
215	*Gymnema sylvestre*	Asclepiadaceae	Climber
216	*Gynandropsis gynandra*	Cleomaceae	Herb
217	*Habenaria viridiflora*	Orchidaceae	Herb
218	*Hardwickia binata*	Caesalpiniaceae	Tree
219	*Hedyotis affinis*	Rubiaceae	Herb

S.No	Species	Family	Habit
220	*Hedyotis biflora*	Rubiaceae	Herb
221	*Hedyotis brachiata*	Rubiaceae	Herb
222	*Hedyotis corymbosa*	Rubiaceae	Herb
223	*Hedyotis herbacea*	Rubiaceae	Herb
224	*Hedyotis puberula*	Rubiaceae	Herb
225	*Helicteres isora*	Sterculiaceae	Shrub
226	*Heliotropium bracteatum*	Boraginaceae	Herb
227	*Heliotropium indicum*	Boraginaceae	Herb
228	*Hemidesmus indicus*	Periplocaceae	Climber
229	*Heteropogon contortus*	Poaceae	Herb-Grass
230	*Heteropogon polystachyos*	Poaceae	Herb-Grass
231	*Hibiscus micranthus*	Malvaceae	Undershrub
232	*Hibiscus rosa-sinensis*	Malvaceae	Shrub
233	*Hibiscus vitifolius*	Malvaceae	Undershrub
234	*Holoptelea integrifolia*	Ulmaceae	Tree
235	*Hugonia mystax*	Linaceae	Liana
236	*Hybanthus enneaspermus*	Violaceae	Herb
237	*Hydrilla verticillata*	Hydrocharitaceae	Herb
238	*Hydrolea zeylanica*	Hydrophyllaceae	Herb
239	*Hyptis suaveolens*	Lamiaceae	Undershrub
240	*Ichnocarpus frutescens*	Apocynaceae	Climber
241	*Indigofera aspalathoides*	Fabaceae	Herb
242	*Indigofera linifolia*	Fabaceae	Herb
243	*Indigofera linnaei*	Fabaceae	Herb
244	*Indigofera tinctoria*	Fabaceae	Herb

S.No	Species	Family	Habit
245	*Indigofera trifoliata*	Fabaceae	Herb
246	*Indoneesiella echioides*	Acanthaceae	Herb
247	*Iphigenia indica*	Liliaceae	Herb
248	*Ipomoea aquatica*	Convolvulaceae	Herb
249	*Ipomoea carnea*	Convolvulaceae	Shrub
250	*Ipomoea coptica*	Convolvulaceae	Herb-twiner
251	*Ipomoea pes-tigridis*	Convolvulaceae	Climber
252	*Ipomoea sepiaria*	Convolvulaceae	Climber
253	*Iseilema prostratum*	Poaceae	Herb-Grass
254	*Ixora pavetta*	Rubiaceae	Tree
255	*Jasminum angustifolium*	Oleaceae	Climber
256	*Jatropha gossypifolia*	Euphorbiaceae	Shrub
257	*Justicia adhatoda*	Acanthaceae	Shrub
258	*Justicia eticulat*	Acanthaceae	Herb
259	*Kyllingia nemoralis*	Cyperaceae	Herb-Sedge
260	*Lannea coromandelica*	Anacardiaceae	Tree
261	*Lantana camara*	Verbenaceae	Shrub
262	*Lemna perpusilla*	Lemnaceae	Herb
263	*Lepidagathis cristata*	Acanthaceae	Herb
264	*Lepisanthes tetraphylla*	Sapindaceae	Tree
265	*Leptadenia eticulate*	Asclepiadaceae	Climber
266	*Leptochloa uniflora*	Poaceae	Herb-Grass
267	*Leucaena leucocephala*	Mimosaceae	Tree
268	*Leucas aspera*	Lamiaceae	Herb
269	*Leucas biflora*	Lamiaceae	Herb

S.No	Species	Family	Habit
270	*Leucas diffusa*	Lamiaceae	Herb
271	*Leucas indica*	Lamiaceae	Herb
272	*Limnophila indica*	Scrophulariaceae	Herb
273	*Lindernia ciliata*	Scrophulariaceae	Herb
274	*Lindernia eticulate*	Scrophulariaceae	Herb
275	*Lindernia oppositifolia*	Scrophulariaceae	Herb
276	*Lindernia parviflora*	Scrophulariaceae	Herb
277	*Lipocarpha raynaleana*	Cyperaceae	Herb-Sedge
278	*Ludwigia adscendens*	Onagraceae	Herb
279	*Ludwigia perennis*	Onagraceae	Herb
280	*Luffa eticulates*	Cucurbitaceae	Climber
281	*Madhuca longifolia*	Sapotaceae	Tree
282	*Malvastrum coromandelianum*	Malvaceae	Undershrub
283	*Manilkara hexandra*	Sapotaceae	Tree
284	*Mariscus paniceus*	Cyperaceae	Herb-Sedge
285	*Maytenus emarginata*	celastraceae	Shrub
286	*Melochia corchorifolia*	Sterculiaceae	Herb
287	*Memecylon edule*	Melastamataceae	Shrub
288	*Memecylon umbellatum*	Melastomataceae	Shrub
289	*Merremia emarginata*	Convolvulaceae	Herb-Creeper
290	*Merremia tridentata*	Convolvulaceae	Herb-twiner
291	*Micrococca mercurialis*	Euphorbiaceae	Herb
292	*Mimosa intsia*	Mimosaceae	Shrub-Straggler
293	*Mimosa pudica*	Mimosaceae	Herb
294	*Mitracarpus villosus*	Rubiaceae	Herb

S.No	Species	Family	Habit
295	*Mnesithea laevis*	Poaceae	Herb-Grass
296	*Mollugo nudicaulis*	Molluginaceae	Herb
297	*Mollugo pentaphylla*	Molluginaceae	Herb
298	*Momordica charantia*	Cucurbitaceae	Climber
299	*Morinda pubescens*	Rubiaceae	Tree-Small
300	*Mukia maderaspatana*	Cucurbitaceae	Climber
301	*Muntingia calabura*	Elaeocarpaceae	Tree
302	*Murdannia nudiflora*	Commelinaceae	Herb
303	*Murdannia spirata*	Commelinaceae	Herb
304	*Nerium oleander*	Apocynaceae	Shrub
305	*Nopalea cochenillifera*	Cactaceae	Shrub
306	*Nymphaea pubescens*	Nympheaceae	Herb
307	*Nymphaea nouchali*	Nympheaceae	Herb
308	*Ochna obtusata*	Ochnaceae	Shrub
309	*Ocimum adscendens*	Lamiaceae	Herb
310	*Ocimum americanum*	Lamiaceae	Herb
311	*Ocimum tenuiflorum*	Lamiaceae	Undershrub
312	*Oplismenus compositus*	Poaceae	Herb-Grass
313	*Opuntia elatior*	Cactaceae	Shrub
314	*Opuntia stricta*	Cactaceae	Shrub
315	*Orthosiphon thymiflorus*	Lamiaceae	Herb
316	*Osbeckia zeylanica*	Melastamataceae	Herb
317	*Ottelia alismoides*	Hydrocharitaceae	Herb
318	*Oxystelma secamone*	Asclepiadaceae	Climber
319	*Pachygone ovata*	Menispermaceae	Climber

S.No	Species	Family	Habit
320	*Panicum psilopodium*	Poaceae	Herb-Grass
321	*Parthenium hysterophorus*	Asteraceae	Herb
322	*Paspalidium flavidum*	Poaceae	Herb-Grass
323	*Paspalum distichum*	Poaceae	Herb-Grass
324	*Paspalum scrobiculatum*	Poaceae	Herb-Grass
325	*Passiflora foetida*	Passifloraceae	Climber
326	*Pavonia odorata*	Malvaceae	Herb
327	*Pavonia zeylanica*	Malvaceae	Herb
328	*Pedalium murex*	Pedaliaceae	Herb
329	*Pedilanthus tithymaloides*	Euphorbiaceae	Undershrub
330	*Peltophorum pterocarpum*	Caesalpiniaceae	Tree
331	*Pergularia daemia*	Asclepiadaceae	Climber
332	*Perotis indica*	Poaceae	Herb-Grass
333	*Phoenix pusilla*	Arecaceae	Shrub
334	*Phoenix sylvestris*	Arecaceae	Tree
335	*Phyla nodiflora*	Verbenaceae	Herb
336	*Phyllanthus amarus*	Euphorbiaceae	Herb
337	*Phyllanthus debilis*	Euphorbiaceae	Herb
338	*Phyllanthus emblica*	Euphorbiaceae	Tree
339	*Phyllanthus maderaspatensis*	Euphorbiaceae	Herb
340	*Phyllanthus eticulates*	Euphorbiaceae	Shrub-Straggler
341	*Phyllanthus virgatus*	Euphorbiaceae	Herb
342	*Physalis angulata*	Solanaceae	Herb
343	*Physalis lagascae*	Solanaceae	Herb
344	*Pistia stratiotes*	Araceae	Herb

S.No	Species	Family	Habit
345	*Pithecellobium dulce*	Mimosaceae	Tree
346	*Plumbago zeylanica*	Plumbaginaceae	Herb
347	*Polyalthia longifolia*	Annonaceae	Tree
348	*Polycarpaea corymbosa var. corymbosa*	Caryophyllaceae	Herb
349	*Polycarpaea corymbosa var. longipetala*	Caryophyllaceae	Herb
350	*Polygala arvensis*	Polygalaceae	Herb
351	*Pongamia pinnata*	Fabaceae	Tree
352	*Portulaca quadrifida*	Portulacaceae	Herb
353	*Portulaca suffruticosa*	Portulacaceae	Herb
354	*Premna corymbosa*	Verbenaceae	Shrub-Straggler
355	*Premna tomentosa*	Verbenaceae	Shrub
356	*Prosopis juliflora*	Mimosaceae	Tree
357	*Pseudarthria viscida*	Fabaceae	Herb
358	*Psidium guajava*	Myrtaceae	Tree-Small
359	*Psilanthus wightianus*	Rubiaceae	Shrub
360	*Pterolobium hexapetalum*	Caesalpiniaceae	Shrub-Straggler
361	*Pupalia lappacea*	Amaranthaceae	Herb
362	*Pycnospora lutescens*	Fabaceae	Herb-Twiner
363	*Pycreus pumilus*	Cyperaceae	Herb-Sedge
364	*Reissantia indica*	celastraceae	Shrub-Straggler
365	*Rhynchosia aurea*	Fabaceae	Herb-Creeper
366	*Rhynchosia rufescens*	Fabaceae	Herb-Twiner
367	*Richardia scabra*	Rubiaceae	Herb
368	*Ricinus communis*	Euphorbiaceae	Shrub

S.No	Species	Family	Habit
369	*Rivea hypocrateriformis*	Convolvulaceae	Liana
370	*Rotala rosea*	Lythraceae	Herb
371	*Rotala verticillaris*	Lythraceae	Herb
372	*Ruellia tuberosa*	Acanthaceae	Herb
373	*Sansevieria roxburghiana*	Dracenaceae	Herb
374	*Santalum album*	Santalaceae	Tree
375	*Sapindus emarginatus*	Sapindaceae	Tree
376	*Sarcostemma acidum*	Asclepiadaceae	Climber
377	*Sauropus bacciformis*	Euphorbiaceae	Herb
378	*Scoparia dulcis*	Scrophulariaceae	Herb
379	*Scutia myrtina*	Rhamnaceae	Shrub
380	*Sebastiania chamaelea*	Euphorbiaceae	Herb
381	*Secamone emetica*	Asclepiadaceae	Climber
382	*Securinega leucopyrus*	Euphorbiaceae	Shrub
383	*Setaria pumila*	Poaceae	Herb-Grass
384	*Setaria verticillata*	Poaceae	Herb-Grass
385	*Sida acuta*	Malvaceae	Herb
386	*Sida cordata*	Malvaceae	Herb
387	*Sida cordifolia*	Malvaceae	Undershrub
388	*Sida schimperiana*	Malvaceae	Undershrub
389	*Solanum americanum*	Solanaceae	Herb
390	*Solanum torvum*	Solanaceae	Shrub
391	*Solanum trilobatum*	Solanaceae	Climber

S.No	Species	Family	Habit
392	*Solanum virginianum*	Solanaceae	Herb
393	*Solena amplexicaulis*	Cucurbitaceae	Climber
394	*Spermacoce articularis*	Rubiaceae	Herb
395	*Spermacoce hispida*	Rubiaceae	Herb
396	*Spirodela polyrhiza*	Lemnaceae	Herb
397	*Sporobolus coromandelianus*	Poaceae	Herb-Grass
398	*Sporobolus indicus*	Poaceae	Herb-Grass
399	*Stachytarpheta jamaicensis*	Verbenaceae	Herb
400	*Stenosiphonium russellianum*	Acanthaceae	Undershrub
401	*Streblus asper*	Moraceae	Tree
402	*Striga angustifolia*	Scrophulariaceae	Herb
403	*Strychnos lenticellata*	Loganiaceae	Liana
404	*Stylosanthes fruticosa*	Fabaceae	Herb
405	*Synedrella nodiflora*	Asteraceae	Herb
406	*Syzygium cumini*	Myrtaceae	Tree
407	*Tamarindus indica*	Caesalpiniaceae	Tree
408	*Tarenna asiatica*	Rubiaceae	Shrub
409	*Tectona grandis*	Verbenaceae	Tree
410	*Tephrosia maxima*	Fabaceae	Herb
411	*Tephrosia pumila*	Fabaceae	Herb
412	*Tephrosia purpurea*	Fabaceae	Herb
413	*Tephrosia villosa*	Fabaceae	Herb
414	*Teramnus labialis*	Fabaceae	Herb

S.No	Species	Family	Habit
415	*Terminalia bellirica*	Combretaceae	Tree
416	*Terminalia catappa*	Combretaceae	Tree
417	*Terminalia chebula*	Combretaceae	Tree
418	*Theriophonum minutum*	Araceae	Herb
419	*Thespesia populnea*	Malvaceae	Tree
420	*Tiliacora acuminata*	Menispermaceae	Liana
421	*Tinospora cordifolia*	Menispermaceae	Climber
422	*Toddalia asiatica*	Rutaceae	Shrub-Straggler
423	*Tragia involucrata*	Euphorbiaceae	Climber
424	*Tragus roxburghii*	Poaceae	Herb-Grass
425	*Trianthema portulacastrum*	Aizoaceae	Herb
426	*Tribulus lanuginosis*	Zygophyllaceae	Herb
427	*Trichuriella monsoniae*	Amaranthaceae	Herb
428	*Tridax procumbens*	Asteraceae	Herb
429	*Triumfetta rhomboidea*	Tiliaceae	Undershrub
430	*Turnera subulata*	Turneraceae	Undershrub
431	*Tylophora indica*	Asclepiadaceae	Climber
432	*Typha angustifolia*	Typhaceae	Rheed
433	*Urena lobata*	Malvaceae	Undershrub
434	*Utricularia caerulea*	Lentibulariaceae	Herb
435	*Utricularia graminifolia*	Lentibulariaceae	Herb
436	*Utricularia polygaloides*	Lentibulariaceae	Herb
437	*Utricularia scandens*	Lentibulariaceae	Herb
438	*Ventilago madraspatana*	Rhamnaceae	Liana
439	*Vernonia cinerea*	Asteraceae	Herb

S.No	Species	Family	Habit
440	*Vetiveria zizanioides*	Poaceae	Grass
441	*Vicoa indica*	Asteraceae	Herb
442	*Vitex negundo*	Verbenaceae	Shrub
443	*Waltheria indica*	Sterculiaceae	Herb
444	*Wattakaka volubilis*	Asclepiadaceae	Liana
445	*Wrightia tinctoria*	Apocynaceae	Tree
446	*Xanthium indicum*	Asteraceae	Undershrub
447	*Xyris pauciflora*	Xyridaceae	Herb
448	*Ziziphus mauritiana*	Rhamnaceae	Tree-Small
449	*Ziziphus oenoplia*	Rhamnaceae	Shrub-Straggler
450	*Ziziphus xylopyrus*	Rhamnaceae	Tree-Small
451	*Zornia diphylla*	Fabaceae	Herb

Source: Nehru et al 2009

15.0 APPENDICES

Family level contribution to the Flora of Nanmangalam Reserve Forest

S.No.	Family	Species	Genus
1	Acanthaceae	13	11
2	Agavaceae	1	1
3	Aizoaceae	1	1
4	Amaranthaceae	10	8
5	Amaryllidaceae	1	1
6	Anacardiaceae	2	2
7	Annonaceae	2	2
8	Apocynaceae	5	5
9	Aponogetonaceae	1	1
10	Araceae	2	2
11	Arecaceae	3	2
12	Asclepiadaceae	10	10
13	Asteraceae	13	12
14	Barringtoniaceae	1	1
15	Bignoniaceae	1	1
16	Boraginaceae	4	3
17	Cactaceae	4	3
18	Caesalpiniaceae	16	7
19	Capparidaceae	5	3
20	Caryophyllaceae	1	1
21	Celastraceae	2	2
22	Cleomaceae	4	2
23	Combretaceae	5	3
24	Commelinaceae	6	4
25	Convolvulaceae	10	4
26	Cordiaceae	2	2
27	Cucurbitaceae	9	9
28	Cyperaceae	13	7
29	Dioscoreaceae	1	1
30	Dracenaceae	1	1
31	Droseraceae	2	1

32	Ebenaceae	3	1
33	Elaeocarpaceae	1	1
34	Eriocaulaceae	1	1
35	Euphorbiaceae	25	15
36	Fabaceae	40	22
37	Flocourcaceae	1	1
38	Gentianaceae	2	2
39	Hydrocharitaceae	2	2
40	Hydrophyllaceae	1	1
41	Hypoxidaceae	1	1
42	Lamiaceae	13	7
43	Lauraceae	1	1
44	Lemnaceae	2	2
45	Lentibulariaceae	4	1
46	Liliaceae	4	4
47	Linaceae	1	1
48	Loganiaceae	1	1
49	Lythraceae	3	2
50	Malvaceae	14	7
51	Melastamataceae	3	2
52	Meliaceae	1	1
53	Menispermaceae	4	4
54	Mimosaceae	13	8
55	Molluginaceae	3	2
56	Moraceae	6	2
57	Myrtaceae	3	3
58	Nyctaginaceae	2	1
59	Nymphaeceae	2	1
60	Ochnaceae	1	1
61	Oleaceae	1	1
62	Onagraceae	2	1
63	Opiliaceae	1	1
64	Orchidaceae	2	2
65	Passifloraceae	1	1
66	Pedaliaceae	1	1
67	Periplocaceae	1	1

68	Plumbaginaceae	1	1
69	Poaceae	52	34
70	Polygalaceae	1	1
71	Portulacaceae	2	1
72	Rhamnaceae	5	3
73	Rubiaceae	19	12
74	Rutaceae	3	3
75	Santalaceae	1	1
76	Sapindaceae	5	5
77	Sapotaceae	2	2
78	Scrophulariaceae	9	6
79	Solanaceae	7	3
80	Sterculiaceae	4	4
81	Tiliaceae	4	3
82	Turneraceae	1	1
83	Typhaceae	1	1
84	Ulmaceae	1	1
85	Verbenaceae	8	7
86	Violaceae	1	1
87	Vitaceae	2	2
88	Xyridaceae	1	1
89	Zygophyllaceae	1	1
Total		**449**	**313**

Source: Nehru et al 2009